Series 1959, No. 10

Issued July 1962

SOIL SURVEY

Carson County, Texas

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
in cooperation with
TEXAS AGRICULTURAL EXPERIMENT STATION

HOW TO USE THE SOIL SURVEY REPORT

THIS SURVEY will serve several groups of readers. It will help farmers in planning the kind of management that will protect their soils and provide good yields; assist engineers in selecting sites for roads, buildings, ponds, and other structures; serve as a reference for students and teachers; and add to the knowledge of soil scientists.

In making this survey, soil scientists checked the fields and native grassland in all parts of the county. They dug holes and examined surface soils and subsoils; measured slopes with a hand level; noted differences in growth of crops, weeds, and grasses; and recorded observations about the soils that they believed might affect their suitability for farming, engineering, and other uses.

The scientists plotted the boundaries of the soils on aerial photographs. Then, cartographers prepared from the photographs the detailed soil map in the back of this report. Fields, roads, and many other landmarks can be seen on the map.

Locating the Soils

Use the index for the map sheets to locate areas on the large map. The index is a small map of the county on which numbered rectangles have been drawn to show where each sheet of the large map is located. The boundaries of the soils are outlined on each sheet of the soil map, and there is a symbol for each kind of soil. All areas marked with the same symbol are the same kind of soil, wherever they appear on the map. The symbol will be inside the area if there is enough space; otherwise, it will be outside the area and a pointer will show where it belongs.

Suppose, for example, an area located on the map has the symbol BeC. The legend for the detailed map shows that this symbol identifies Berthoud fine sandy loam, 3 to 5 percent slopes. This soil and all others mapped in the county are described in the section "Descriptions of the Soils."

Finding Information

The soil survey report has special sections for different groups of readers, as well as sections that may be of value to all.

Farmers and ranchers can learn about the soils in the section "Descriptions of the Soils" and then identify them on their land. They can learn how these soils can be managed by reading the section "Use and Management."

The soils are placed in capability units; that is, groups of soils that need similar management and respond in about the same way. For example, in the section "Descriptions of the Soils," Berthoud fine sandy loam, 3 to 5 percent slopes, is shown to be in capability unit IVe-2 (dryland farming or irrigation). This capability unit is discussed in the section "Use and Management."

The soils are placed in range sites, which are kinds of rangeland. Each range site has its own potential for production of grasses and other vegetation. For example, Berthoud fine sandy loam, 3 to 5 percent slopes, is placed in the Mixed Land Slopes range site. A description of each range site is given in the section "Range Management."

The "Guide to Mapping Units, Capability Units, and Range Sites" at the back of the report will simplify the use of the map and the report. The guide gives the name and map symbol for each soil and the page on which the soil is described, and the capability units and range site in which the soil has been placed and the page on which each unit is described.

Help in making plans for farms or ranches can be obtained through a local representative of the Soil Conservation Service or the county agricultural agent. Members of the staff of the Texas Agricultural Experiment Station and others familiar with farming in Carson County will also be glad to help.

Engineers will want to refer to the section "Engineering Applications." Tables in that section show characteristics of the soils that affect engineering.

Soil scientists and others interested in the scientific aspect of the soils will find information about how the soils were formed and how they are classified in the section "Formation, Classification, and Morphology of the Soils."

Students, teachers, and other users will find information about the soils and their management in various parts of the report, depending on their particular interest.

Newcomers in Carson County will be especially interested in the section "General Soil Areas," which describes the broad pattern of the soils. They may also wish to read the section "Additional Facts About the County."

* * * * *

This cooperative soil survey was made by the United States Department of Agriculture and the Texas Agricultural Experiment Station to provide a basis for determining the best agricultural uses of the soils. The Soil Conservation Service completed the fieldwork in 1959, and unless otherwise specified, all statements in this report refer to conditions at that time. The soil survey is part of the technical assistance furnished to the McClellan Creek Soil Conservation District, formerly part of the Staked Plains Soil Conservation District.

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SOIL SURVEY OF CARSON COUNTY, TEXAS

SURVEY BY LOUIS L. JACQUOT, LUTHER C. GEIGER, BILLY R. CHANCE, DONALD A. LEATH, AND LYNDON C. IMKE, SOIL CONSERVATION SERVICE

REPORT BY LOUIS L. JACQUOT

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE TEXAS AGRICULTURAL EXPERIMENT STATION

CARSON COUNTY is in the north-central part of the Texas Panhandle (fig. 1). The total land area is 576,000 acres, or 900 square miles. The southern two-thirds of the county is a nearly level, treeless plain. The rest has mainly rolling relief. About 60 percent of the county is in cultivation. Wheat and grain sorghum are the principal crops, but some corn, barley, oats, and cotton are grown. Some areas are irrigated. The production of beef cattle is an important industry. The oil and gas industries provide employment to many residents.

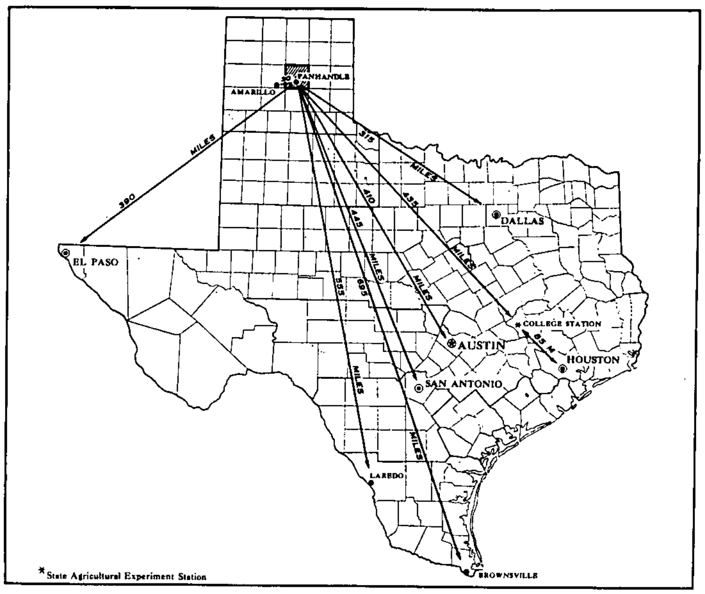

Figure 1.—**Location of Carson County in Texas.**

General Soil Areas

Carson County has two main regions, the High Plains and the Rolling Plains. In these regions, or land resource areas, there are five general soil areas that are sometimes called associations. In the High Plains there is one association; in the Rolling Plains there are four. These associations are shown on the colored map at the back of this report.

An understanding of the general soil areas is helpful in planning the development and the protection of natural resources. These resources include native range, cropland for dryland farming and irrigation, and water.

Brief descriptions of the two main regions and the general soil areas in each follow. For more detailed information about the soils, see the detailed soil map and the section "Descriptions of the Soils."

High Plains

The southern two-thirds of Carson County is a nearly level, elevated, but treeless area called the High Plains. The High Plains is a part of the Great Plains, which is the largest, most uniform, fertile mass of land in North America. It includes most of the Texas Panhandle. This nearly featureless plain is a strip, roughly 200 to 500 miles wide, that parallels the eastern side of the Rocky Mountains. It was once a short-grass paradise for buffalo and Plains Indians. In less than half a century, nearly all of this fertile area has been brought under cultivation and now produces mainly sorghum and wheat.

The elevation of the High Plains in the county ranges from 3,300 feet to nearly 3,575 feet above sea level. It slopes very gently from west to east, except where cut by playas and the McClellan Creek drainage system. In the Canadian River Valley and other places, the mantle of the High Plains has been removed by geologic stream erosion. By cutting a deep valley into the original smooth High Plains, geologic stream erosion has advanced the front of the Rolling Plains. Figure 2 shows the general relationship of the soils in Carson County.

The upland surface of the High Plains is a nearly level to gently sloping plain that is irregularly pitted by many depressions or playas (natural dryland lakes). These playas hold runoff water and probably contribute to the water table of the High Plains. Surface drainage is in the extremely youthful stage. It is mostly trapped by many intermittent lakes or playas throughout the area. The playas have no surface outlets, except where the small, shallow ones overflow and drain into larger playas at lower elevations.

In Carson County most of the vast High Plains consists of uniform, deep, moderately fine textured, fertile soils.

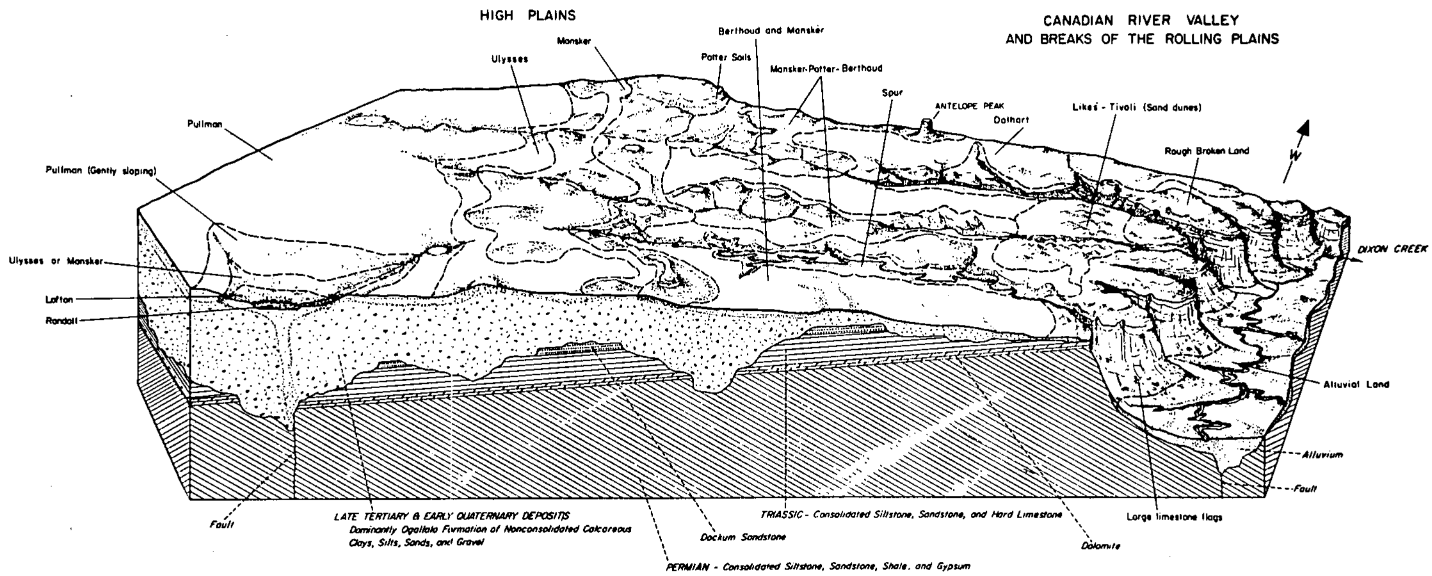

Figure 2.—**General relationship of the soils in Carson County.**

The remainder consists of soils formed in the bottoms of playas and scattered areas of calcareous soils within and bordering the High Plains (fig. 3).

General Soil Area of the High Plains

Pullman-Randall association: Fine or moderately fine textured soils

This general soil area, or association, comprises nearly level to gently sloping, deep, slowly to very slowly permeable clay loams and clays that are called hardlands. It contains 385,000 acres.

About 75 percent is dry-farmed, 15 percent is irrigated, and 10 percent is used for native short grass range. Pullman soils make up about four-fifths of this area. Soils in shallow depressions or playas make up the rest (fig.4).

The soils in the depressions are largely used for native grass range. They are Randall clay, Church silty clay, Lofton silty clay loam, Ulysses clay loam, Zita clay loam, and some sloping Pullman soils. Small, scattered areas of Olton clay loam in the vicinity of Skellytown are included. Narrow bands of Ulysses, Mansker, and Potter soils occur mainly above the escarpment remnants and isolated knolls and ridges northeast of Pantex Ordnance Plant.

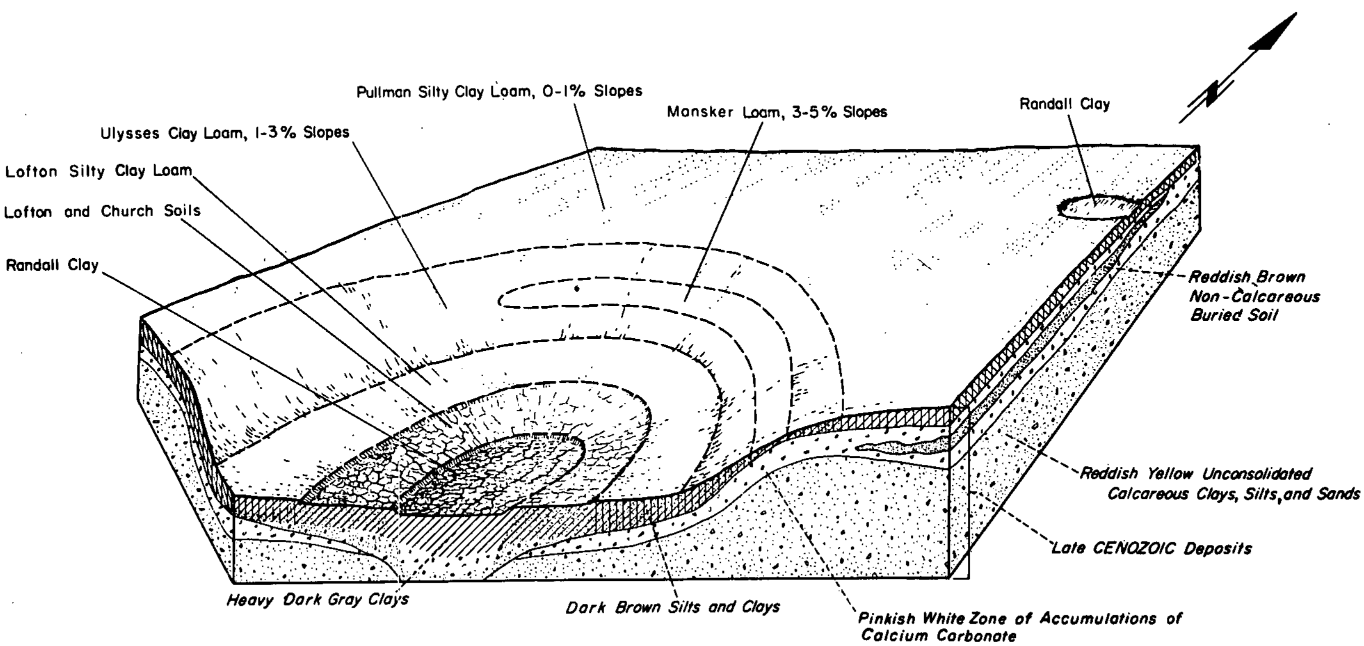

Figure 3.—**A representative pattern of soils in one of the playas of the Pullman-Randall soil association.**

Figure 4.—**A well-managed shallow playa lake provides abundant grazing.**

Most of the Lofton soils and large acreages of Ulysses soils are used for crops. Olton soils are also productive; but because they occur in small areas, they are mainly in native range.

Rolling Plains

About one-third of the county lies in the Rolling Plains. The land has characteristic rolling relief and well-developed surface drainage. The tracts are partly hardlands, partly mixed lands containing several fine sandy loam soils, and smaller areas of rough, broken lands and sandhills.

A broad, transitional zone, 8 to 12 miles wide, lies between the High Plains and the Canadian River Breaks. This transitional zone is now included with the Rolling Plains because there is some similarity of soils and of other features. It includes subdued remnant escarpments, hills, ridges, and physiographic terraces that penetrate deeply into the Rolling Plains. The elevation ranges from about 3,000 feet to 3,550 feet above sea level. The major intermittent streams are Antelope, Dixon, Bear, and White Deer Creeks. These streams flow northward into the Canadian River. McClellan Creek originates near the south-central part of the county and flows southeast into Gray County. These intermittent streams are usually deeply entrenched in the typical, narrow valley floors.

Geologic erosion has removed much of the sediment from the High Plains that originally covered the deposits of the Rolling Plains. In places, such as the breaks near the Canadian River, little or no High Plains sediment remains (see fig. 2). Here, the streams have carved deeply into the colorful Triassic and Permian red beds. About 15 percent of this part of the county consists of arable soils, but nearly all of it is used as rangeland for cattle (fig. 5).

The vegetation of the Rolling Plains is mainly mixed grasses, but there are a few trees at some of the springs and waterholes along the natural watercourses. There are some low shrubs on the sandier soils.

Because of extensive oil and gas development, the northwestern part of the rangeland within the Rolling Plains has the appearance of oilfields. Very limited amounts of this area have been cleared for cultivation because of the large ranches in the area and because of soil characteristics that restrict use for cultivation.

General Soil Areas of the Rolling Plains

Mansker-Berthoud loams association: Medium-textured soils

This general soil area, or association, comprises gently sloping to rolling, shallow to deep, moderately to slowly permeable loams of the hardlands. It contains 72,000 acres. The soils in this general area occur in the uplands of the eroded plains, mostly next to the High Plains. They consist mainly of Mansker and Berthoud loams, but there are appreciable areas of Bippus and Olton clay loams.

This general soil area is well dissected by intermittent streams. It is an excellent area for blue grama and buffalograss. Included are a few, intermingled areas of steeper slopes along some of the draws, where side-oats grama and catclaw grow.

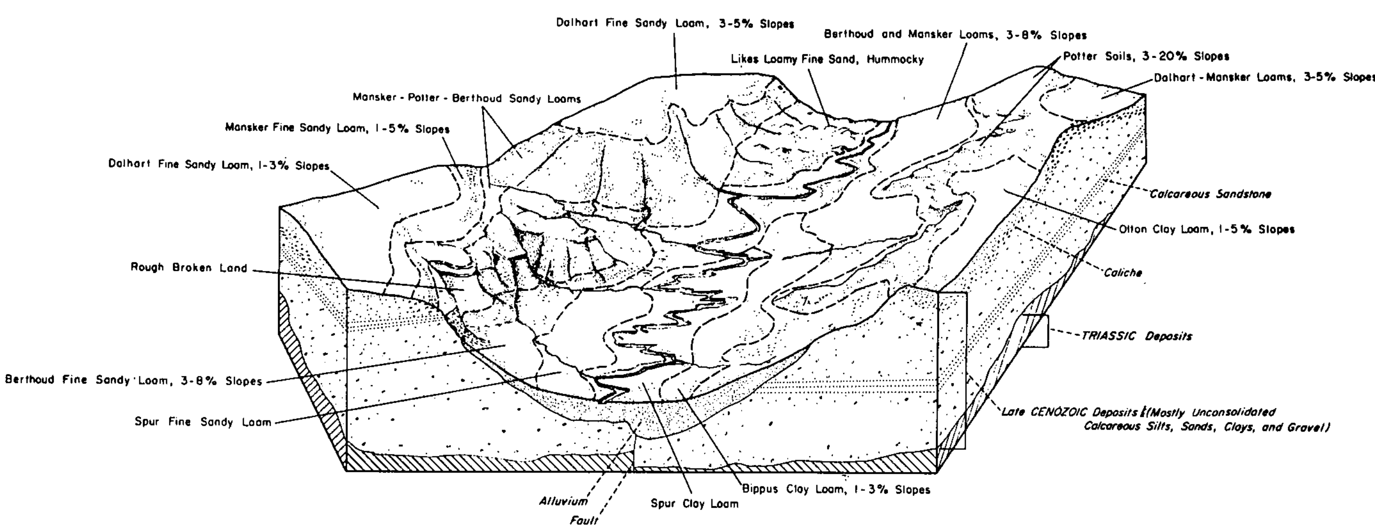

Figure 5.—**Several major soils of the Canadian River Valley of the Rolling Plains. The ranges in slope shown on this figure are those that exist where the figure was drawn.**

Except for a few patches of Bippus, Spur, and Olton clay loams used for supplemental feed, the soils of this association are used for native range.

Mansker-Berthoud fine sandy loams association: Moderately coarse textured soils

This general soil area, or association, comprises shallow to deep, moderately permeable fine sandy loams of the mixed lands. It contains 71,000 acres. The soils are well drained and moderately fertile.

Berthoud and Mansker fine sandy loams are the main soils, but minor areas of Potter fine sandy loam are included (fig. 6). Mansker and Potter soils are usually on the steeper slopes. Berthoud fine sandy loam, which is less extensive than Mansker fine sandy loam, occurs on foot slopes. It is friable, calcareous, and of medium depth.

Small areas of Dalhart fine sandy loam also occur. This is a deep soil that formed in a mantle of wind-laid sediment on upland terraces of the eroded plains. Dalhart fine sandy loam occurs mostly in the vicinity of Fritch (Hutchinson County) and as isolated areas extends as far east as Skellytown. Large areas of this soil were once farmed; however, they are now in native range because of low yields and susceptibility to wind erosion.

Because of susceptibility to erosion, the soils of this general soil area are used only for native rangeland.

Berthoud-Potter association: Hilly, rough breaks

This general soil area, or association, consists of deep to very shallow, steep and hilly Berthoud and Potter fine sandy loams and the stony rough lands over red beds. It contains 39,000 acres. About 65 percent of this general area is made up of Berthoud-Potter soils, which support fair to poor cover of mid grasses.

Except for inclusions of Gravelly rough land and of colluvial and alluvial material, the rest consists of rugged land types that provide very limited grazing for livestock. Such rough, scenic land types are good areas for game refuges.

Likes-Tivoli association: Hummocky to dunelike sandy soils

This general soil area, or association, comprises immature but deep, rapidly permeable, coarse sandy soils of the sandy lands. It contains 9,000 acres. Likes soils are hummocky and are the most extensive. Tivoli soils are the least developed in the county and occur on sand dunes.

The soils of this general area are held in place mainly by bluestem, sand dropseed, sandreed, sand sagebrush, skunkbush, and some yucca. Since these soils are highly susceptible to wind erosion, they are used only for light grazing.

Descriptions of the Soils

The soil scientists who made this survey went over the area at appropriate intervals and dug holes with a spade, auger, or power soil sampler. They examined the different layers, or horizons, in each boring, and they compared the different borings. Examinations were generally made by traveling across the prevailing slopes and digging holes not more than a quarter mile apart. In complex, arable

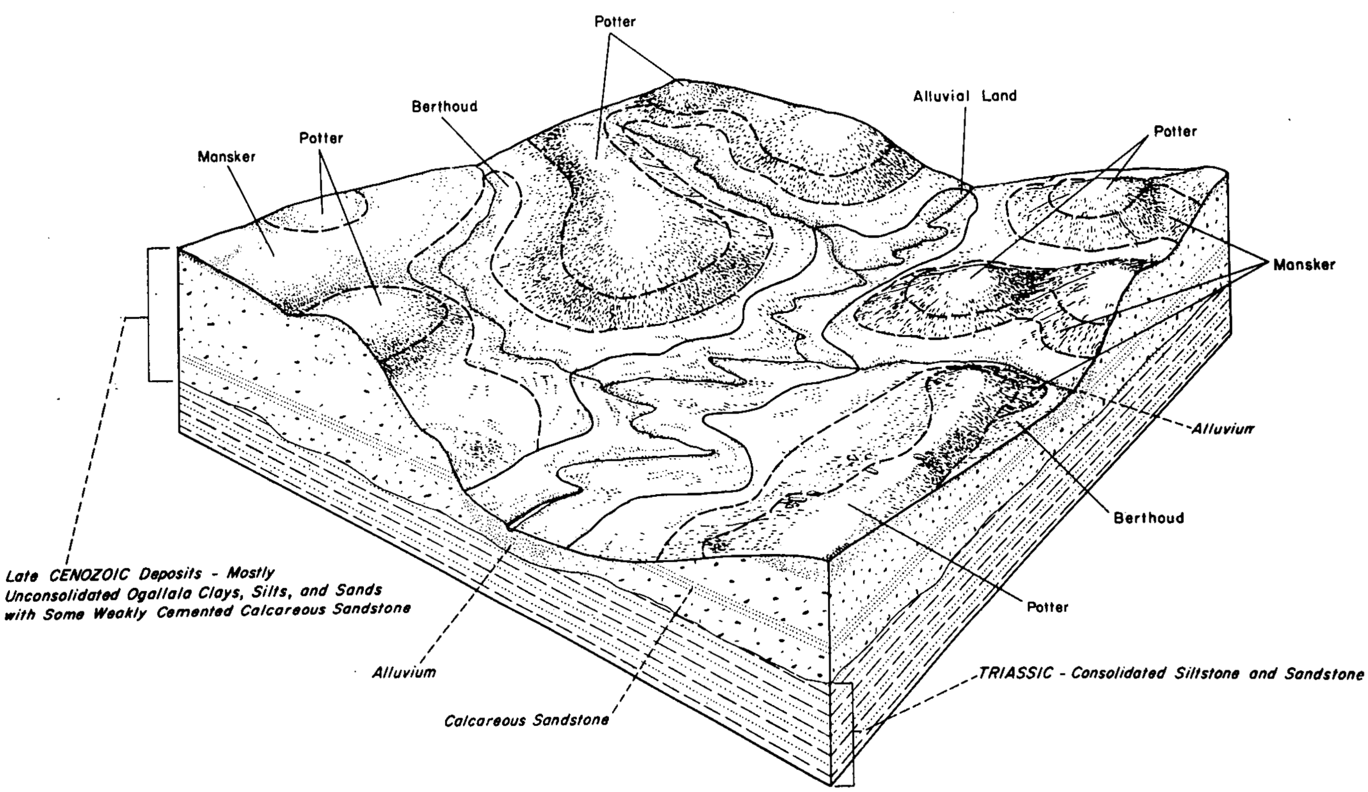

Figure 6.—**Typical arrangement of soils in the Mansker-Potter-Berthoud sandy loams complex. The dashed lines indicate boundaries of the component soils.**

areas, however, the holes were much closer together. During this survey, the scientists examined many thousands of holes and soil cores. The holes and cores revealed several distinct layers, or horizons, which are known collectively as the soil profile. By study of the different horizons in each boring and comparison of the different borings, the scientists determined the different kinds of soils in the area.

Then, they described the various soils and drew boundaries on aerial photographs to separate them. The soils are described in the following pages. Their acreage and proportionate extent are shown in table 1, and their location can be seen on the detailed map at the back of this report.

In this report, the soil series are described in alphabetic order. After each series, the soils of that series that were mapped in the county are described. An important part of each soil description is the soil profile, a record of what the soil scientist saw and learned when he dug into the ground. Since all the soils in one series have essentially the same profile, except for possible differences in texture of the surface layer, it is not necessary to describe the profile of every soil. A representative profile is therefore described for each series. Photographs of several profiles are also shown. On each photograph the soil horizon symbols are given on the left, and the depth of the horizon, in inches, is given on the right.

For example, the profile described for the Berthoud series is that of Berthoud fine sandy loam, 3 to 5 percent slopes. The reader can assume that all the Berthoud soils mapped have essentially this kind of profile. The differences, if any, are indicated in the soil name, or mentioned in describing the particular soil.

In describing the soils, the scientist frequently assigns a letter symbol, for example, "A_1," to the various layers. These letter symbols have special meanings that concern scientists and others who desire to make a special study of soils. Most readers need to remember only that all letter symbols beginning with "A" are surface soil and subsurface soil; those beginning with "B" are subsoil; and those beginning with "C" are substratum, or parent material. It may also be helpful to remember that the small letter "p" indicates a plowed layer and that the small letters "ca" indicate an accumulation of calcium carbonate.

Layers, or horizons, in soils are measured from the top of the mineral soil material downward. The distance from the top to the bottom of each layer is indicated in inches. In soils, one layer is seldom followed immediately by another layer in such a way that they can be divided by a straight line. Boundaries between horizons have thickness and shape. The terms for thickness are (1) *abrupt*, if less than 1 inch thick; (2) *clear*, if about 1 to 2½ inches thick; (3) *gradual*, if 2½ to 5 inches thick; and (4) *diffuse*, if more than 5 inches thick. The shape of the boundary is described as *smooth*, *wavy*, *irregular*, or *broken*.

Soil scientists use Munsell notations to indicate the color of a soil precisely, and they provide the equivalent in words for those not familiar with the system. They compare a sample of the soil with a standard color chart. The Munsell notation, and its less exact approximation in words, are read from the chart; for example, "grayish brown (10YR 5/2; 4/2)." In the example given, "10YR" is the hue, and "5/2" and "4/2" each express, respectively, value and chroma in hue 10YR. The notation "10YR 5/2" is equivalent to the words "grayish brown;" it is the hue, value, and chroma of the soil when dry. The notation "10YR 4/2" indicates the hue, value, and chroma of the soil when moist. To save space in this report, the notation for the dry soil always comes first, and it is not followed by the word "dry."

Other technical terms are explained in the Glossary in the back of this report.

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Map symbol	Soil	Area	Extent
		Acres	*Percent*
Au	Alluvial land	3, 100	0. 5
BeC	Berthoud fine sandy loam, 3 to 5 percent slopes	7, 700	1. 3
BfD	Berthoud and Mansker fine sandy loams, 3 to 8 percent slopes	43, 700	7. 6
BmD	Berthoud and Mansker loams, 3 to 8 percent slopes	24, 800	4. 3
BrB	Bippus clay loam, 1 to 3 percent slopes	2, 640	. 5
DaB	Dalhart fine sandy loam, 1 to 3 percent slopes	5, 240	. 9
DaC	Dalhart fine sandy loam, 3 to 5 percent slopes	4, 900	. 8
DmC	Dalhart-Mansker loams, 3 to 5 percent slopes	27, 400	4. 8
Gr	Gravelly rough land	695	. 1
Lk	Likes loamy fine sand, hummocky	6, 220	1. 1
Lo	Lofton silty clay loam	12, 170	2. 1
Ls	Lofton and Church soils	6, 880	1. 2
MkB	Mansker loam, 1 to 3 percent slopes	1, 115	. 2
MkC	Mansker loam, 3 to 5 percent slopes	12, 075	2. 1
MkC2	Mansker loam, 3 to 5 percent slopes, eroded	4, 345	. 8
Mx	Mansker-Potter-Berthoud sandy loams	43, 400	7. 5
OcB	Olton clay loam, 1 to 3 percent slopes	5, 200	. 9
OcC	Olton clay loam, 3 to 5 percent slopes	6, 350	1. 1
Ps	Potter soils	8, 680	1. 5
PuA	Pullman silty clay loam, 0 to 1 percent slopes	251, 500	43. 7
PuB	Pullman silty clay loam, 1 to 3 percent slopes	37, 000	6. 4
PuB2	Pullman silty clay loam, 1 to 3 percent slopes, eroded	14, 090	2. 4
Ra	Randall clay	16, 860	2. 9
RcB	Richfield clay loam, 1 to 3 percent slopes	440	. 1
Ro	Rough broken land	3, 800	. 7
Rs	Rough stony land	2, 690	. 5
Rw	Riverwash	200	(1)
Sc	Spur clay loam	1, 370	. 2
Sp	Spur fine sandy loam	900	. 2
Tv	Tivoli fine sand	1, 175	. 2
UcA	Ulysses clay loam, 0 to 1 percent slopes	2, 720	. 5
UcB	Ulysses clay loam, 1 to 3 percent slopes	10, 050	1. 7
UcB2	Ulysses clay loam, 1 to 3 percent slopes, eroded	2, 420	. 4
VoB	Vona fine sandy loam, 1 to 3 percent slopes	2, 165	. 4
ZcA	Zita clay loam, 0 to 1 percent slopes	990	. 2
ZcB	Zita clay loam, 1 to 3 percent slopes	1, 020	. 2
	Total	576, 000	100. 0

[1] Less than 0.1 percent.

Alluvial Land

Alluvial land (Au).—This mapping unit consists of several different kinds of alluvial material. These materials were deposited in narrow, intermittent stream valleys, mostly in the northern one-third of the county. The deposits consist of dark grayish-brown to brown, mostly well-drained material of varied textures. Areas of Alluvial land include adjoining channel banks and coarse-textured streambeds. The soil ranges from about neutral to calcareous and is moderately fertile.

Because of scar channels, hummocks or knolls, and low ridges left by frequent overflow from streams, these areas are nonarable. They are best used for controlled grazing after a good native grass has been established. (Capability unit Vw-1; Bottom Land range site.)

Berthoud Series

The Berthoud series consists of deep, light-colored, loamy, moderately permeable soils. These soils are calcareous throughout but do not have prominent layers of caliche in the subsoil. They occupy local foot slopes of colluvium and alluvium below the escarpment and the remnants of the High Plains. A profile of a Berthoud soil is shown in figure 7.

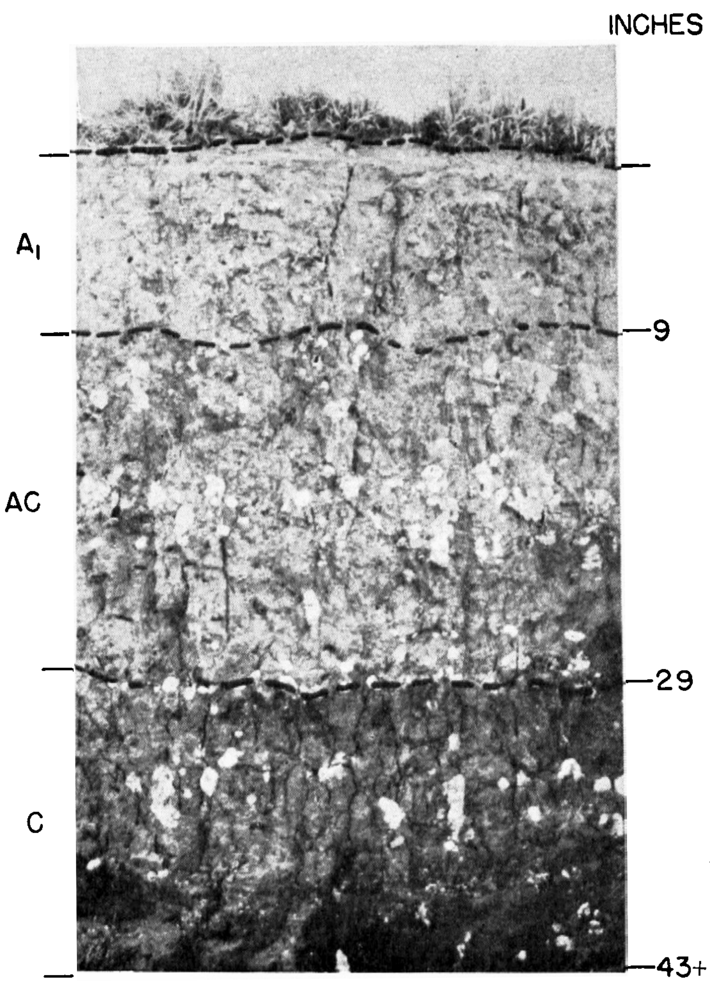

Figure 7.—**Profile of a Berthoud soil.**

These soils of the uplands are closely related to and associated with the Bippus soils, which are darker, less calcareous, and slightly more developed. The Berthoud soils occur mostly in more sloping, higher lying areas than the Bippus soils. Typically they are between the Bippus soils and the escarpment materials that consist mainly of Mansker and Potter soils.

Normal geologic erosion has produced shallow, receding scarps that are characteristic of these soils. The number of these scarps apparently varies with the slope.

Most of the Berthoud soils are nonarable and are used for range. They generally support a moderate to good cover of native short and mid grasses. Side-oats grama, blue grama, and little bluestem are the main grasses. Scattered shrubs of yucca, cactus, and mesquite grow in some places.

Profile description (2.52 miles south and 0.93 mile east of main 6666 Ranch headquarters, 0.47 mile east of Texas Highway No. 15):

A_1 0 to 8 inches, grayish-brown (10YR 5/2; 4/2, moist) fine sandy loam; weak, coarse, prismatic structure that breaks easily to weak, subangular blocky and granular; very friable when moist; many wormcasts and roots; few, fine to medium, hard nodules of calcium carbonate; strongly calcareous; gradual boundary.

AC 8 to 30 inches, brown (7.5YR 5/3; 4/3, moist) light sandy clay loam; compound structure—weak, coarse, prismatic that breaks easily to weak, medium, subangular blocky and granular; very friable; many wormcasts and fine roots; few to common, medium, hard nodules of calcium carbonate; very strongly calcareous; gradual boundary.

C 30 to 42 inches, light brownish-gray (10YR 6/2; 5/2, moist) heavy fine sandy loam; weak, medium and fine, granular structure; many, fine pores and channels; roots and wormcasts are less common; strongly calcareous; abrupt boundary.

C_b 42 to 65 inches +, yellowish-brown (10YR 5/4; 4/4, moist) light clay; strong, fine, irregular blocky structure; sticky when wet, firm when moist; few, fine roots and few, fine and medium, soft concretions of calcium carbonate throughout the horizon; strongly calcareous.

The thickness of the A horizon ranges from 8 to 14 inches and the color from brown to grayish brown. Although clay loam to sandy loam textures occur, lighter colored fine sandy loam is the dominant texture.

The AC horizon ranges from 12 to 26 inches, or more, in thickness. The content of hard and soft caliche in this layer varies in most places. As the slope increases, fine and medium, hard concretions of calcium carbonate generally are more common throughout the profile. These concretions are exposed on the surface where erosion has thinned the A horizon. In less sloping areas, few or no hard concretions are within the upper 2 to 3 feet of the soil.

Berthoud fine sandy loam, 3 to 5 percent slopes (BeC).—This soil has the profile described as typical of the Berthoud series. The dominant slopes are between 4 and 5 percent. This soil includes small knobs of Mansker and Potter soils and small, transitional border areas of Bippus soils. The inclusions comprise up to 8 percent of the mapping unit. (Capability unit IVe-2 (dryland farming or irrigation); Mixed Land Slopes range site.)

Berthoud and Mansker fine sandy loams, 3 to 8 percent slopes (BfD).—This undifferentiated unit occurs mainly in the gently to moderately sloping areas next to and north of the area of Berthoud and Mansker loams, which is adjacent to the smooth High Plains. It consists of about 60 percent

Berthoud fine sandy loam, 30 percent Mansker fine sandy loam, and about 10 percent Potter soils. However, the percentages of the soils vary considerably in different parts of the county.

Areas of these soils are mostly rolling, but they include low hills and knolls occupied mostly by Mansker soils and a few small, strongly sloping areas occupied by Potter soils. The Berthoud soil and minor inclusions of Dalhart and Spur soils occupy the more extensive areas in swales and on gentle foot slopes. Here, the vegetation is markedly that of the Mixed Land Slopes range site and consists mainly of blue grama, little bluestem, sand dropseed, and, in places, yucca.

The Berthoud soil in this unit is similar to that described for the series. Mansker fine sandy loam is a nonarable, shallow, calcareous member of this mapping unit. It is similar to Mansker loam (described elsewhere in the report); however, the surface layer is 7 to 12 inches of fine sandy loam, and the subsoil is slightly sandier than that of Mansker loam. (Capability unit VIe-2; Mixed Land Slopes range site.)

Berthoud and Mansker loams, 3 to 8 percent slopes (BmD).—Most of the soils of this undifferentiated unit are in a narrow strip in the transitional area between the High Plains and the Rolling Plains in the north-central part of the county. This mapping unit consists of about 50 percent Berthoud and 40 percent Mansker soils. About 10 percent consists of inclusions of Dalhart, Bippus, Spur, and Potter soils. The percentage of the component soils varies considerably in the areas mapped, but that of the Berthoud soil is generally the largest.

These soils occur in an area that is characterized by low knolls and ridges and swales and gentle slopes. The knolls and ridges are occupied by Mansker soil and minor inclusions of Potter soils. The swales and gentle foot slopes are occupied mostly by Berthoud soil and minor inclusions of Dalhart and Spur soils.

This mapping unit has the vegetation of the Hardland Slopes range site, which consists mainly of blue grama and buffalograss in the swales and foot slopes. Side-oats grama and some catclaw shrubs are on the knolls and ridges.

A profile of a Berthoud soil is described under the Berthoud series. Berthoud loam is similar to Berthoud fine sandy loam but is a heavier textured loam or light clay loam throughout. A profile of a Mansker soil is described under the Mansker series. (Capability unit VIe-1; Hardland Slopes range site.)

Bippus Series

The Bippus soils are well drained, deep, dark, and moderately permeable, These young soils formed on local alluvial foot slopes and fans in the Rolling Plains. The parent material consists of strongly calcareous, local sediment that has washed from higher lying deposits of the weathered plains. These soils of the lower foot slopes generally occur between the higher lying Berthoud soils and the slightly lower Spur soils of the Rolling Plains.

Associated soils are of the Likes, Berthoud, Spur, Mansker, and Potter series. The Likes soils are much sandier and less developed structurally. The Berthoud soils are lighter colored, shallower, and occupy steeper slopes. The Spur soils occur in lower lying, nearly level valleys that are adjacent to and a little above the stream channel. A distinctive characteristic of the Bippus soils is the prominent, very thick, dark A_1 horizon that is noncalcareous in most places.

The transitional AC horizon in these soils has some coarse, rounded concretions of calcium carbonate that are scattered rather uniformly throughout the horizon.

If these soils receive plenty of moisture, they are fertile and highly productive. Only a very small acreage within the range area, however, is tilled to produce supplemental feed for livestock. Most of the area is used as native range. Because of extra runoff from the adjoining steeper slopes, the Bippus soils generally support a dense cover of short and mid grasses, mainly buffalograss and blue grama.

Profile description (about 11.5 miles north of Farm Road No. 293 on Texas Highway No. 15; then 4.25 miles east on 6666 Ranch Road and 50 feet south of road):

A_1 0 to 14 inches, dark grayish-brown (10YR 4/2; 3/2, moist) to dark-brown (10YR 4/3; 3/3, moist) clay loam to sandy clay loam; compound structure—moderate, medium, fine, granular to weak, coarse, prismatic; friable when moist, hard when dry; wormcasts and nests are common; fine biological pores are common; many grass roots; few, fine to medium, rounded quartz and caliche pebbles; noncalcareous; gradual boundary.

AC 14 to 27 inches, dark-brown (7.5YR 4/2; 3/2, moist) clay loam; compound structure—moderate, coarse, prismatic and moderate, fine, granular (largely wormcasts); less friable when moist, hard when dry; many films and false mycelia of calcium carbonate; few, fine to medium, rounded quartz and caliche pebbles are evenly scattered throughout the horizon; many fine biological pores and channels; strongly calcareous; gradual boundary.

C 27 to 50 inches +, brown (7.5YR 5/2; 4/2, moist) clay loam; compound structure—weak, coarse, prismatic and moderate, fine, granular; friable when moist; about 5 percent of the volume is a weak concentration of fine and medium, soft and hard, rounded concretions of calcium carbonate; very strongly calcareous; gradual boundary.

The texture of the A_1 horizon is dominantly clay loam, but it ranges from sandy clay loam to silty clay loam. The color when the soil is dry ranges from very dark grayish brown to dark brown, hue 10YR to 7.5YR. The reaction of the soil ranges from noncalcareous in the A horizon to strongly calcareous in the AC horizon. The amount of very fine to medium, soft and hard, segregated calcium carbonate in the lower part of the AC and the C horizons ranges from slight to about 5 percent of the soil mass. Grass roots steadily decrease in volume with increasing depth. Few roots occur below a depth of about 60 inches.

In the northern part of the county, the soils have a distinct reddish hue. The parent material is a mixture of calcareous material of the High Plains and red-bed sediment of the Rolling Plains. As a result, there is more color in the subsoil.

Bippus clay loam, 1 to 3 percent slopes (BrB).—This soil has the profile described as typical of the Bippus series. Except for slight variations in color, texture, and relief, this soil is fairly uniform in all areas. In places a few of the mapped areas include areas (less than 5 acres in size) of Berthoud and Spur soils. As all of this soil is in a part of the county used chiefly for range, only a very small acreage is used for supplemental feed crops. (Capability unit IIIe-2 (dryland farming or irrigation); Hardland range site.)

Church Series

The Church soils in Carson County are mapped only with the Lofton soils as an undifferentiated unit (Lofton and Church soils).

Profile description (undisturbed area, 200 feet east and 75 feet north from the southwest corner of section 56, block 4, H. and G.N. RR. Survey, about 2 miles east of White Deer):

A_{11} 0 to 4 inches, very dark gray (10YR 3/1; 2/1, moist) silty clay; moderate, fine, granular to moderate, fine, subangular blocky structure; sticky when wet, friable when moist, hard when dry; many roots concentrated in horizon; strongly calcareous; clear boundary.

A_{12} 4 to 40 inches, dark-gray (10YR 4/1; 3/1, moist) clay; moderate to strong, coarse and medium, blocky structure to massive; very sticky when wet, extremely hard when dry; few, very fine roots follow ped surfaces; nearly impervious to water when wet; shrinkage cracks, ½ inch to 5 inches wide and 1 to 4 feet or more deep, occur in regular pattern when the soil is dry; strongly calcareous; gradual boundary.

AC 40 to 58 inches, dark grayish-brown (10YR 4/2; 3/2, moist) clay; sticky when wet, very hard when dry; massive; few, fine, hard concretions of calcium carbonate; very strongly calcareous; clear boundary.

C 58 to 80 inches +, grayish-brown (2.5Y 5/2; 4/2, moist) clay; strong, very fine, irregular blocky structure; sticky when wet, extremely hard when dry; few, very fine root channels; very fine concretions of calcium carbonate common; very strongly calcareous.

The thickness of the silty clay A horizon is as much as 40 inches in places. The color of this horizon ranges from gray to very dark gray. In a few of the playas, the texture ranges from clay to clay loam. The depth to the weak C_{ca} horizon, if present, ranges from 37 to 58 inches. Church soils have very slow surface drainage and very slow internal drainage.

Dalhart Series

The Dalhart series consists of deep, mature, well-drained, brown to dark-brown soils. The surface soil is brown fine sandy loam or loam, and the subsoil is dark-brown sandy clay loam. Buried soils commonly occur below 36 inches. Similar sediments underlie the Pullman soils.

Dalhart soils formed in eolian deposits and in outwash from the reddish-brown plains, mainly under a cover of mid grasses. They are mostly on the smoother, convex surfaces in the uplands on the eroded plains in the northwestern part of the county. They are in a few fairly large, isolated areas and have slopes mainly between 1 and 4 percent.

Associated soils are the Bippus soils, which are darker brown but less mature; and the Berthoud soils, which are shallower, much less developed, and calcareous throughout the profile.

The vegetation consists mainly of little bluestem and blue grama. There are some yucca plants, patches of sand sagebrush in lighter textured areas, and a few invading mesquite trees.

Profile description (200 feet east and 75 feet north from the southwest corner of section 22, block 7, I. and G.N. RR. Survey):

A_1 0 to 9 inches, dark-brown (7.5YR 4/2; 3/2, moist) fine sandy loam; compound structure—weak, coarse, prismatic and moderate, fine, granular; very friable when moist, slightly hard when dry; strong hoofpan, which is 2 inches thick and overlain by about three-fourths of an inch of fine platy or silty eolian material; wormcasts, roots, and fine pores are common; noncalcareous; gradual boundary.

B_2 9 to 22 inches, dark-brown (7.5YR 4/2; 3/2, moist) sandy clay loam; compound structure—moderate, coarse, prismatic and moderate, medium, blocky; friable when moist, hard when dry; wormcasts, fine roots, and fine biological pores and channels are slightly less common than in lower part of the A_1 horizon; noncalcareous; gradual boundary.

B_3 22 to 34 inches, brown (7.5YR 5/2; 4/2, moist) sandy clay loam; compound structure—moderate, coarse, prismatic and moderate, medium, blocky; wormcasts and nests common; fine pores common; many specks, fine threads, and patchy films of calcium carbonate coat ped surfaces; strongly calcareous; clear boundary.

C_{ca} 34 to 54 inches, light-brown (7.5YR 6/4; 4/4, moist) light sandy clay loam; moderate, medium, prismatic and granular structure; very strongly calcareous; contains much soft, white, segregated calcium carbonate; abrupt boundary.

D 54 to 57 inches +, pinkish-gray (7.5YR 6/2; 5/2, moist) hard caliche.

The thickness of the noncalcareous A_1 horizon ranges from 7 to 13 inches and averages 9 inches. The color ranges from dark brown to brown. The texture is dominantly fine sandy loam but ranges from sandy clay loam to sandy loam. The combined thickness of the noncalcareous B_2 and calcareous B_3 horizons ranges from 20 to 38 inches or more and averages about 25 inches. The color ranges from dark brown to light brown. The texture is mainly sandy clay loam but ranges from light clay loam to sandy clay loam.

Usually a prominent, very strongly calcareous C_{ca} horizon is at depths of 2 to 6 feet or more. It ranges from light brown to very pale brown. This horizon usually is sandy clay loam and contains 10 to 30 percent or more of soft, segregated calcium carbonate. In many places there are dark layers of buried soils below 30 inches. In a few places, a D horizon of unrelated, hard caliche occurs.

Dalhart fine sandy loam, 1 to 3 percent slopes (DaB).—This soil has the profile described as typical of the Dalhart series. Included with this soil are small areas of Mansker fine sandy loam and fringe areas of Dalhart fine sandy loam, 3 to 5 percent slopes. In places these areas may comprise about 6 percent of this Dalhart soil. (Capability unit IIIe–3 (dryland farming or irrigation); Mixed Land range site.)

Dalhart fine sandy loam, 3 to 5 percent slopes (DaC).—This soil is slightly less dark and more reddish than Dalhart fine sandy loam, 1 to 3 percent slopes. Dominant slopes are 3 to 5 percent, but small areas with slopes up to about 7 percent are included.

This soil occurs in fairly small areas that generally have plane or convex surfaces. It occurs in association with more sloping, nonarable soils. It is suited to crops but is very susceptible to wind erosion under cultivation. Most of the soil is in native grass and is used for range. Small areas of Mansker and Berthoud soils are included in some mapped areas. (Capability unit IVe–2 (dryland farming or irrigation); Mixed Land range site.)

Dalhart-Mansker loams, 3 to 5 percent slopes (DmC).—This soil complex occurs mainly in the smoother, convex old erosional terraces in the area transitional from the High Plains to the Rolling Plains. These terraces surround the low hills and ridges and partly surround the encroachment draws. The smoother areas are mostly occupied by Dalhart loams, which make up about 60 per-

cent of the mapping unit. The low hills, ridges, and side slopes of the draws are mostly occupied by Mansker loams, which make up about 30 percent of the unit. Berthoud and Bippus soils, on the flatter draws and foot slopes, make up the rest.

Slopes of this complex of soils range from about 3 to 8 percent but are dominantly about 3 to 5 percent. Vegetation consists mainly of blue grama and some buffalograss on the Dalhart soil. Side-oats grama and a few yucca and catclaw shrubs are on the Mansker soil. A Mansker soil is described under the Mansker series. (Capability unit VIe-1; Hardland Slopes range site.)

Gravelly Rough Land

Gravelly rough land (Gr).—This land type is locally called gravelly hills. It characteristically occupies smooth, gravel-capped knobs and hills between deposits of the erosional plains and those of the exposed red beds. Sandy lands that occur on the swales between the gravel hills are included with this land type. These areas have little or no surface gravel.

Geologic erosion has removed most of the finer deposits of the erosional plains and has left a mantle of very coarse, waterworn gravel and cobbles. Soft sandstone and hard limestone underlie this mantle. In places a very shallow, calcareous soil has formed. The cobbly and gravelly mantle characteristically makes a smooth cover that is effective in resisting erosion on slopes of 8 to 60 percent. Miniature landslides are common on the steeper slopes.

Although sparse, native vegetation is of good quality and is mostly accessible to livestock. It consists mainly of little bluestem, side-oats grama, and hairy grama. A few yucca, juniper, and catclaw shrubs grow between the cobbles and gravel mulch. Bluestem and sand sagebrush are the main range plants on the sandy land inclusion. (Capability unit VIIs-1; Rough Breaks range site.)

Likes Series

The Likes soils are grayish brown to light brown, rapidly permeable, and sandy. They are immature soils on strongly calcareous colluvium and outwash materials. They occur on uplands below escarpments and hills in the Rolling Plains of the county.

The Likes soils are closely related to the Berthoud soils that have formed on finer textured local colluvium and alluvium. The Likes soils are much sandier, more sloping, and lighter colored than the Bippus soils.

The vegetation consists mainly of bluestem, sand dropseed, and grama. Sand sagebrush is characteristic of the landscape, and a few yucca plants and skunkbushes occur. These soils are highly susceptible to wind erosion if overgrazed or if the cover is destroyed.

Profile description (2,270 yards north and 538 yards east of a point where the main 6666 Ranch Road crosses escarpment on east side of Dixon Creek):

A_1 0 to 9 inches, brown (10YR 5/3; 4/3, moist) loamy fine sand; compound structure—weak, fine, granular and single grained; very friable when moist, soft when dry; roots common; wormcasts few to common; few, fine to coarse, rounded, hard concretions of calcium carbonate; noncalcareous; gradual boundary.

AC 9 to 40 inches, pale-brown (10YR 6/3; 4/3, moist) loamy fine sand; structure is similar to that of the A_1 horizon; few waterworn quartz pebbles; fewer roots than in layer above; few, fine pores; slightly calcareous; gradual boundary.

C 40 to 78 inches +, light yellowish-brown (10YR 6/4; 5/4, moist) loamy fine sand; very friable; few, fine roots; films of calcium carbonate few to common; very fine concretions of calcium carbonate common; strongly calcareous.

The texture ranges from light sandy loam to loamy fine sand. Loamy fine sand is by far the dominant texture. The color of the A horizon ranges from grayish brown to light brown. The reaction is generally slightly calcareous in the upper part of these soils to strongly calcareous at depths of 15 to 40 inches or more.

Likes loamy fine sand, hummocky (Lk).—This soil has the profile described as typical of the Likes series. It has characteristics that limit its use to range. (Capability unit VIIe-1; Sandy Land range site.)

Lofton Series

The Lofton series consists of very dark, deep, loamy, very slowly permeable soils. These soils formed from dark-brown to grayish-brown local sediments of the High Plains. The sediments were mainly silts and clays. Lofton soils occur in small tracts throughout the areas of nearly level, fine-textured soils of the county. They are on the higher playa benches or wide stream bottoms where geologic erosion has connected a succession of playas to form natural stream channels. These soils are also on narrow, depressed bands slightly above and around the smaller playas, or in small slight depressions within areas of Pullman soils. A profile of a Lofton soil is shown in figure 8.

The associated soils are the less dark, gently sloping Pullman soils that surround these soils; and the dark-gray, poorly to very poorly drained Randall clay, which occurs on the playa bottoms. The associated Randall clay is less well developed than the Lofton soils.

The native vegetation consists mainly of buffalograss, blue grama, and some western wheatgrass. Lofton soils are not very extensive and are mostly under cultivation. They are among the most productive soils of the High Plains because they receive extra water from surrounding higher areas.

Profile description of a typical Lofton soil (cultivated field, 2,100 feet west and 1,700 feet north of the southeast corner of section 21, block 7, I. and G.N. RR. Survey, or about 1.5 miles east of White Deer):

A_p 0 to 6 inches, very dark grayish-brown (10YR 3/2; 2/2, moist) silty clay loam; weak, fine and very fine, granular structure to structureless; slightly sticky when wet, friable when moist, and hard when dry; noncalcareous; abrupt, clear boundary.

B_{21} 6 to 15 inches, very dark grayish-brown (10YR 3/2; 2/2, moist) clay; compact, moderate, medium, platy structure in upper 2 inches caused by tillage; moderate to strong, medium, blocky structure in lower part; sticky when wet, extremely hard when dry; few, fine and very fine pores and channels; a mixture of dark organic stains and thin, patchy clay films on ped surfaces; noncalcareous; clear, smooth boundary.

B_{22} 15 to 64 inches, dark grayish-brown (10YR 4/2; 3/2, moist) silty clay; moderately strong, medium, blocky structure; sticky and plastic when wet, very hard when dry; few, very fine channels; darkly stained, nearly continuous clay films on ped surfaces:

few, fine and medium concretions of calcium carbonate; weakly to strongly calcareous; clear boundary.

B_{2b} 64 to 72 inches, reddish-brown (5YR 5/4; 4/4, moist) clay loam; friable when moist, hard when dry; fine to medium, hard concretions of calcium carbonate common, and mostly between vertical ped surfaces; strongly calcareous; clear boundary.

C_{cab} 72 to 80 inches +, light reddish-brown (5YR 6/4; 5/4, moist) clay loam; friable when moist, hard to slightly hard when dry; very strongly calcareous; about 20 to 25 percent of volume is soft calcium carbonate.

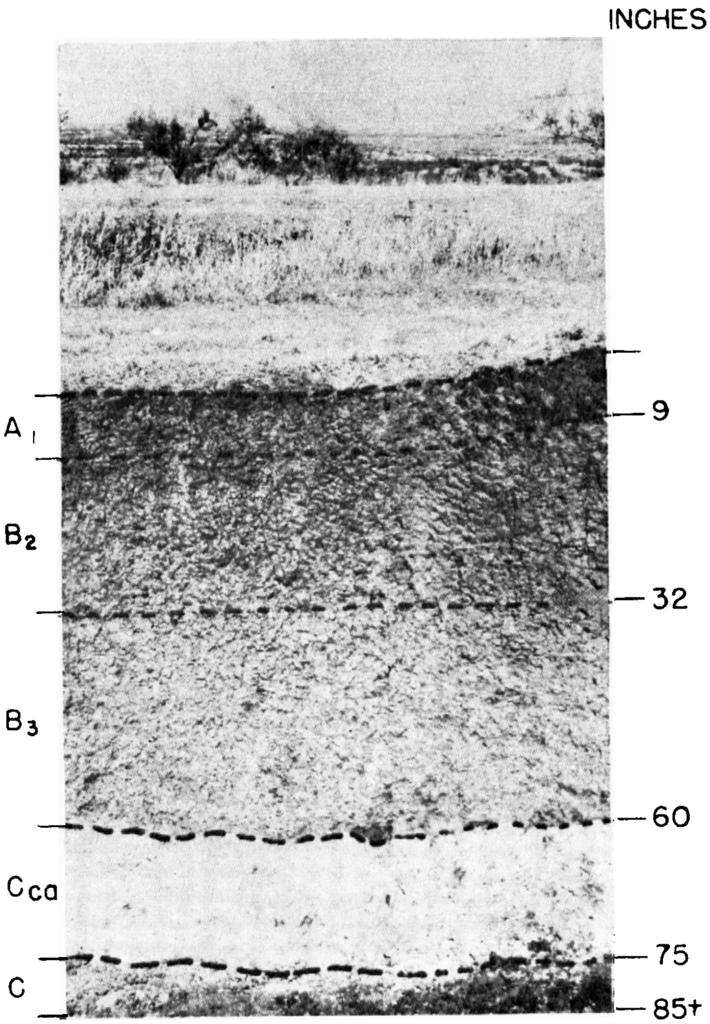

Figure 8.—**Profile of a Lofton soil.**

The thickness of the A_1 horizon ranges from 6 to 10 inches, and the color ranges from grayish brown to very dark grayish brown in the lower chromas and values of the 10YR hue. The dominant slopes are from 0 to 0.5 percent. A buried soil, as shown in the profile description (B_{2b} and C_{cab} horizons), occurs in many places.

Profile of a Lofton soil mapped only with the Church series as an undifferentiated unit (undisturbed area, 1,300 feet north and 200 feet east of the southwest corner of section 56, block 4, or about 2 miles east and 1.5 miles north of Washburn):

A_1 0 to 10 inches, very dark gray (10YR 3/1; 2/1, moist) silty clay loam to light silty clay; weak to moderate, very fine, blocky and granular structure; sticky when wet, hard when dry; roots and fine biological channels common; surface 1 inch is weak, thin, platy silty clay loam outwash; noncalcareous; gradual boundary.

B_{21} 10 to 20 inches, very dark gray (10YR 3/1; 2/1, moist) stiff clay; strong, medium and coarse, blocky peds that are in vertical strings; very sticky when wet, firm when moist, extremely hard when dry; some flattened roots between peds; few, fine and very fine biological pores and channels; noncalcareous; gradual boundary.

B_{22} 20 to 50 inches, very dark grayish-brown (10YR 3/2; 2/2, moist) clay slightly mottled with brown; massive to weak, blocky structure; consistence similar to that of B_{21} horizon; few, fine roots in upper part; slightly calcareous; gradual boundary.

C 50 to 65 inches +, gray (10YR 5/1; 4/1, moist) clay; massive; sticky when wet, very hard when dry; few, very fine root channels; few, fine, soft concretions of calcium carbonate in lower part; strongly calcareous.

The A horizon is slowly permeable silty clay loam to light clay. It ranges from 8 to 11 inches in thickness and from dark gray (10YR 4/1; 3/1, moist) to very dark gray (10YR 3/1; 2/1, moist) in color.

The B horizon is very slowly permeable, slightly mottled clay and ranges from 10 to 40 inches or more in thickness. It is mostly very dark grayish brown.

In the smaller and shallower playas, a C_{ca} horizon, 8 to 15 inches thick, is present below a depth of 26 inches. In the large playas, however, it is not present, even at a depth of 86 inches. A gray (10YR 5/1; 4/1, moist), stiff, massive clayey C horizon is in most places at depths of 37 to 80 inches or more. A small acreage of these soils is under cultivation.

Lofton silty clay loam (Lo).—This soil has the profile described as typical of the Lofton series. Included in a few cultivated fields are small areas of water-laid sediments, up to 12 inches thick. The sediments came from higher lying Pullman and Ulysses soils. Outside water should be diverted before this soil is irrigated. (Capability unit IIs-1 (irrigation); capability unit IIIce-1 (dryland farming); Hardland range site.)

Lofton and Church soils (Ls).—This mapping unit consists of a complex of dark-brown to dark grayish-brown, poorly drained clayey soils of the Lofton and Church series. These soils occupy the low benches, 4 to 10 feet above the floor of the larger playas. These playa benches range from 40 to 300 acres or more in size. They occur throughout the county. Randall soil is on the bottoms of the playas in association with the soils of this mapping unit.

A typical profile of a Church soil is described under the Church series.

The native vegetation on Lofton and Church soils consists mainly of buffalograss and western wheatgrass. Blue grama and vine-mesquite are less extensive. These are arable soils, but they are occasionally inundated during years when rainfall is above normal. Therefore, they are used mostly as native range. A limited acreage of the Lofton and Church soils is in cultivation. (Capability unit IIs-1 (irrigation); capability unit IIIce-1 (dryland farming); Hardland range site.)

Mansker Series

The Mansker series consists of strongly calcareous, grayish-brown, moderately permeable, shallow soils. These soils have formed mostly from strongly calcareous outwash and wind-laid sediments. The most extensive

bodies of Mansker soils are mainly in broad, irregular areas that are transitional from the High Plains to the stronger relief of the Rolling Plains. Smaller areas occur on the rims of many of the playa depressions. They are also generally below areas of the upper Rolling Plains that have moderately strong relief and border the High Plains. A profile of a Mansker soil is shown in figure 9.

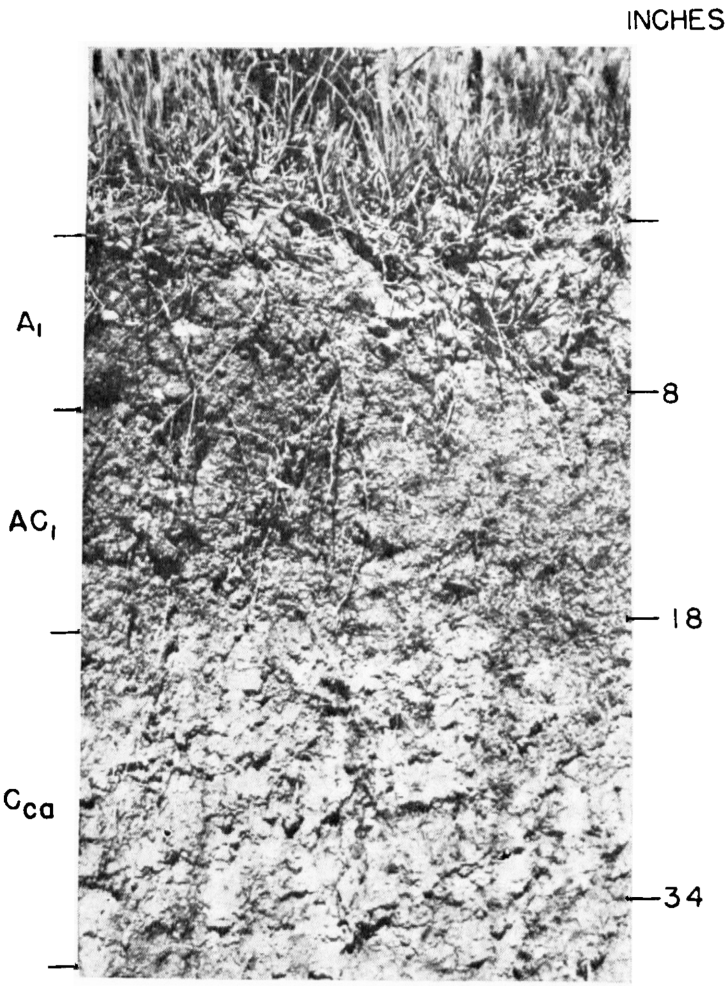

Figure 9.—**Profile of a Mansker soil.**

The associated soils of the High Plains are the Ulysses, which are similar in color but deeper; the Zita, which are darker, deeper, and much less calcareous; and the Pullman, which are deeper and much less permeable and are well developed. Most of these soils are in native pasture.

Profile description (undisturbed area, approximately 1,425 feet north and 1,000 feet west of the southeast corner of section 51, block 5, I. and G.N. RR. Survey, or about 11.25 miles north and 2.25 miles west of Panhandle):

A_1 0 to 9 inches, grayish-brown (10YR 5/2; 4/2, moist) loam to sandy clay loam; weak, very coarse, prismatic structure that breaks very easily to moderate, fine and medium, granular structure; consists mainly of wormcasts in the lower 6 inches; very friable when moist, slightly hard when dry; many roots and fine pores; upper 1 inch is an accumulation that has weak, thin and medium, platy structure; strongly calcareous; gradual boundary.

AC 9 to 17 inches, light brownish-gray (10YR 6/2; 5/2, moist) clay loam; weak, very coarse, prismatic structure that readily breaks to moderate, medium, granular structure (mainly wormcasts); friable when moist; many fine biological pores and channels; roots many to common; few, fine, hard concretions of calcium carbonate scattered throughout the horizon; strongly calcareous; clear boundary.

C_{ca} 17 to 35 inches, light-brown (7.5YR 6/4; 5/4, moist) clay loam; compound structure—weak, very coarse, prismatic and moderate, medium, granular; soft and hard nodules of calcium carbonate make up about 20 to 40 percent of the volume; common to many wormcasts; gradual boundary.

C 35 to 48 inches, light-brown (7.5YR 6/4; 4/4, moist) sandy clay loam; very weak, very coarse, prismatic structure; fine to medium, soft, white concretions of calcium carbonate common; some medium to coarse, hard nodules of calcium carbonate irregularly distributed throughout the horizon; very strongly calcareous; abrupt boundary.

D 48 to 72 inches +, very pale brown (10YR 7/4; 6/4, moist) very fine sandy loam; single-grained structure; soft when dry; weakly calcareous.

The A horizon is strongly calcareous, moderately permeable loam. It is 7 to 9 inches thick and ranges from dark grayish brown to light brownish gray, hue 10YR, value 4 to 6, chroma 2.

The AC horizon is strongly calcareous, moderately permeable clay loam. It is 7 to 10 inches thick and is mostly light brownish gray (10YR 6/2; 5/2, moist). The depth to the C_{ca} horizon ranges from 12 to 18 inches and the thickness from 8 to 24 inches or more.

Mansker loam, 1 to 3 percent slopes (MkB).—This soil is similar to Mansker loam, 3 to 5 percent slopes. It is gently sloping, however, and has a slightly deeper profile. In places inclusions of Ulysses soils make up as much as 10 percent of its area. This shallow, inextensive soil occurs mostly in small areas throughout the High Plains within larger areas of closely associated Ulysses and Zita soils. (Capability unit IVe–2 (dryland farming or irrigation); Hardland range site.)

Mansker loam, 3 to 5 percent slopes (MkC).—This soil has the profile described as typical of the Mansker series. It is on exposed rims that border playas, side slopes of drainageways, and ridges. The slopes are mostly strongly convex and short. They range from less than 200 feet to as much as 600 feet and average about 300 feet. Inclusions of Potter, Ulysses, and eroded Mansker soils comprise 5 to 15 percent of this soil. (Capability unit VIe–1; Hardland Slopes range site.)

Mansker loam, 3 to 5 percent slopes, eroded (MkC2).—This soil is typically on southern and southwestern exposures of playa rims, side slopes of intermittent drainageways, and ridges. The smooth, strong, convex slopes are short, or from 200 to 800 feet in length. The slopes of playa rims average about 300 feet, and those of drainageways and ridges average about 600 feet.

Although its yields are fairly low, this soil generally is farmed with the less sloping, deeper, and more productive Pullman and Ulysses soils. About one-half of the surface soil has been lost through erosion. Included within this soil are minor areas, 1 to 5 acres in size, of Ulysses clay loam.

The surface horizon of Mansker loam, 3 to 5 percent slopes, eroded, is a stronger brown than that described in the profile for the series. It is mostly a clay loam and averages about 4 inches in thickness. Shallow, crossable gullies are common. A few gullies are more deeply

entrenched in places, and in these the parent material is exposed. (Capability unit VIe–1; Hardland Slopes range site.)

Mansker-Potter-Berthoud sandy loams (Mx).—This complex of soils is mostly in the Rolling Plains. It consists of nonarable soils that are used only for range and wildlife. The shallow to very shallow soils of this complex have formed on hard and soft caliche that borders the upper and lower sides of the rough, jagged escarpments next to the High Plains. Also, extensive areas are on subdued escarpments, small narrow valley walls, and hills within the Rolling Plains. Dominantly, the complex consists of about 45 percent Mansker soils, 25 percent Berthoud soils, and about 30 percent Potter soils. The Potter soils dominate on the steeper part of the landscape. However, the percentage of the different soils in the complex varies as much as 25 percent from place to place.

These soils were mapped as a complex because it was impractical to map small areas of each at the scale used.

On the Potter soils in this complex, yucca and catclaw shrubs make up 5 to 10 percent of the vegetation and side-oats grama, three-awn, and little bluestem make up about 10 to 15 percent. Berthoud and Mansker soils have less yucca and catclaw shrubs than the Potter soils, and considerably more grama. They have little or no bluestem. A good cover (25 to 35 percent) of blue grama and some buffalograss is common on the minor inclusions of heavier textured Dalhart and Bippus soils. These inclusions are mostly light clay loam and are in narrow swales and on gentle side slopes.

Profiles of the Mansker, Potter, and Berthoud soils are described under the Mansker, Potter, and Berthoud series, respectively. The Mansker and Berthoud soils in this complex have profiles similar to the typical profiles described except that they have fine sandy loam surface soils. Also, they are somewhat sandier throughout the remainder of the profile. (Capability unit VIe–2; Mixed Land Slopes range site.)

Olton Series

The Olton series consists of deep, dark-brown, slowly permeable loamy soils. These soils generally are between the Pullman soils of the High Plains and the Dalhart soils of the erosional plains. The sediments in which they formed are not quite as sandy or porous and calcareous as those in which the Dalhart soils formed. Sediments similar to those from which the Olton soils formed underlie the nearly level Pullman soils. A profile of an Olton soil is shown in figure 10.

The Olton soils are slightly redder than the Pullman soils. In addition, they have a less compact subsoil of heavy clay loam or light clay instead of clay.

The native vegetation is mainly blue grama and buffalograss. There are a few invading mesquite shrubs in places. Although these soils are arable, less than 5 percent of the acreage is under cultivation. The remaining 95 percent is used for native range.

Profile description (on the 6666 Ranch, 750 feet west and 2,500 feet north of an abandoned farm, about 4 miles west and 14 miles north of Panhandle):

A_1 0 to 9 inches, dark-brown (7.5YR 4/2; 3/2, moist) clay loam; weak, medium, prismatic structure that breaks easily to moderate, fine, granular; very friable when moist, slightly hard when dry; many wormcasts; medium biological pores and channels are common; noncalcareous; gradual boundary.

B_2 9 to 25 inches, reddish-brown (5YR 4/4; 3/4, moist) light clay; moderate, fine and medium, blocky structure; continuous, thin clay films; firm when moist, very hard when dry; roots mostly between peds; worm burrows filled with casts in places; few, fine and very fine roots; noncalcareous; gradual boundary.

B_3 25 to 51 inches, yellowish-red (5YR 5/8; 4/8, moist) sandy clay loam; weak, medium to coarse, blocky structure; friable when moist, hard when dry; wormcasts and fine roots; few, fine films of calcium carbonate; slightly calcareous; clear boundary.

C_{ca} 51 to 70 inches, pinkish-white (5YR 8/2; 7/3, moist) sandy clay loam; about 60 percent of the volume is pinkish-white, soft and hard, medium to coarse concretions of calcium carbonate.

C 70 to 84 inches +, similar to C_{ca} horizon but considerably fewer concretions of calcium carbonate, which are replaced by light-brown (7.5YR 6/4; 5/4, moist), massive silty and sandy clay loam.

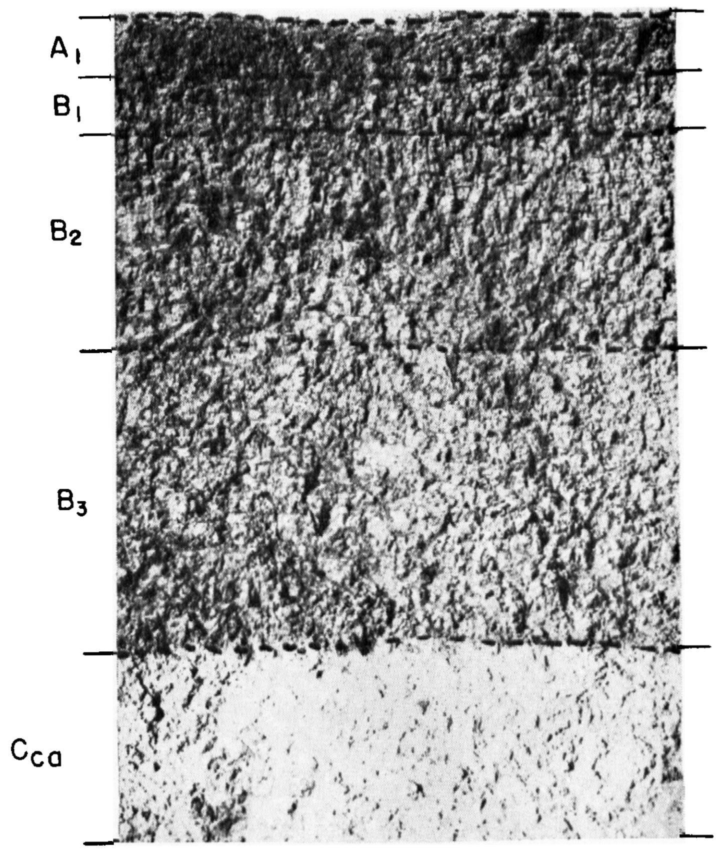

***Figure 10.*—Profile of an Olton soil.**

The thickness of the A horizon ranges from 6 to 9 inches and averages about 7 inches. The texture is most commonly clay loam but ranges from fine sandy loam to clay loam. The color ranges from very dark grayish brown to dark brown, hue 10YR to 7.5YR, value 4, chroma 2 to 3.

The B horizon ranges from grayish brown to reddish brown, hue 10YR to 5YR, value 3 to 4, chroma 2 to 4. The C_{ca} horizon, if present, is at depths ranging from 30 to 60 inches or more.

Olton clay loam, 1 to 3 percent slopes (OcB).—This soil is normally darker, slightly heavier, and deeper than Olton clay loam, 3 to 5 percent slopes. It is better suited to cultivation but is less extensive.

This soil includes most of the cultivated areas of Olton soils in the county. Some areas of this soil are used for

native range. (Capability unit IIIe-1 (dryland farming or irrigation); Hardland range site.)

Olton clay loam, 3 to 5 percent slopes (OcC).—This soil has the profile described as typical of the Olton series. It contains small inclusions of less sloping Olton soil and areas covering less than 5 acres of Mansker and Berthoud soils. (Capability unit IVe-1 (dryland farming); Hardland range site.)

Potter Series

The Potter series consists of strongly calcareous, very shallow soils. These soils formed on lime-cemented beds of caliche and calcareous sandstone. The caliche is made up of hard and soft beds of calcium carbonate as much as several feet thick. Probably these lime-enriched beds were previously deposited by underground water. A profile of a Potter soil is shown in figure 11.

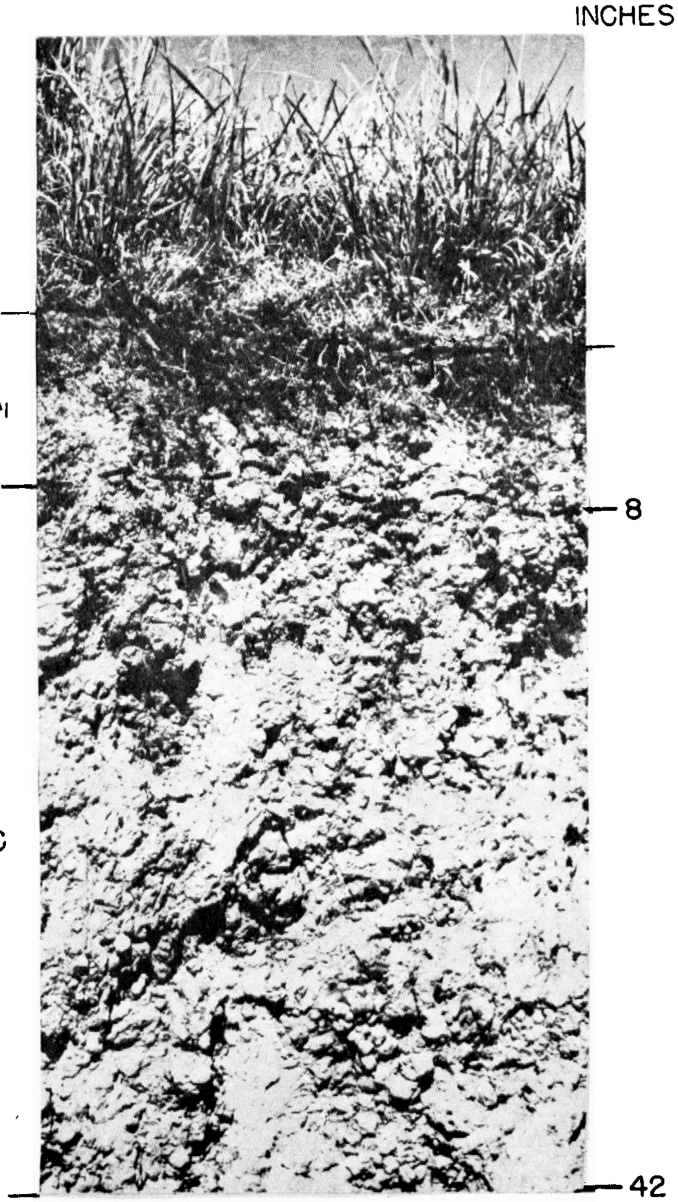

Figure 11.—**Profile of a Potter soil.**

The Potter soils border the smoother escarpment areas and occur on knolls and ridges that deeply penetrate the Rolling Plains. They are on slopes that have a soil mantle less than 10 inches thick. The slope is as much as 50 percent in places but generally does not exceed 30 percent.

The associated Mansker soils are similar to Potter soils except that they are thicker and occur on relief that is not so strong. The miscellaneous land type Rough broken land, which consists of Potter soil material, is steeper, much more cut up, and less accessible to livestock and generally has much less vegetation. The largest total area of Potter soils is in the mapping unit Mansker-Potter-Berthoud sandy loams, which is described elsewhere in this report.

The vegetation consists mainly of side-oats and hairy grama, little bluestem, and three-awn grasses, but yucca and catclaw shrubs are common. These plants together make up about 10 to 30 percent of the ground cover.

Profile description (1,400 feet west and 350 feet north of 6666 Ranch farmstead, about 2 miles north of old abandoned farm on west side of Santa Fe Railroad tracks, about 16 miles north and 4 miles west of Panhandle):

A_1 0 to 9 inches, grayish-brown (10YR 5/2; 4/2, moist) fine sandy loam; weak, fine and very fine, granular structure; very friable when moist, slightly hard when dry; few to many wormcasts; roots common; few to many, fine to coarse caliche nodules and fragments that increase with depth; very strongly calcareous; clear boundary.

C 9 to 32 inches +, white (10YR 8/2; 6/2, moist), partly weathered caliche in the upper 3 inches; small pockets and vertical tonguelike wedges of soil consisting of 90 percent wormcasts and nests extend through the hard caliche into soft caliche at a depth of 26 to 30 inches.

Dominantly the profile is fine sandy loam and about 7 inches thick. The thickness, however, may range from 1 to 10 inches, and the texture, from clay loam to sandy loam. The color of the A horizon ranges from dark grayish brown to light brownish gray, hue 10YR, value 4 to 6, and chroma 2. As the slope of the soil increases, the caliche nodules are more common in and on the soil mantle. Also, with increasing slope, the soil is lighter colored, lighter textured, and shallower because of less favorable environment for soil development. The parent material is partly weathered, hard caliche that is mostly white (10YR 8/2) when dry and light grayish brown (10YR 6/2) when moist.

Potter soils (Ps).—These soils have a profile similar to the one described as typical of the series. Small areas of Mansker and Berthoud soils are included and comprise as much as 10 percent of this mapping unit. (Capability unit VIIs-2; Shallow Land range site.)

Pullman Series

The Pullman series consists of dark grayish-brown, deep, loamy, very slowly permeable soils that have dark-brown clay subsoil. These soils formed in fine-textured, calcareous sediments that probably originated from loess or other windblown material. They make up about four-fifths of the nearly level High Plains part of the county. A profile of a Pullman soil is shown in figure 12.

These soils have little or no relief except where they surround intermittent lakes or playas. The main associated soils that occur in playas are the Lofton, which are darker; the Randall, which are very clayey and are in the playa bottoms; the Zita, which are more friable and

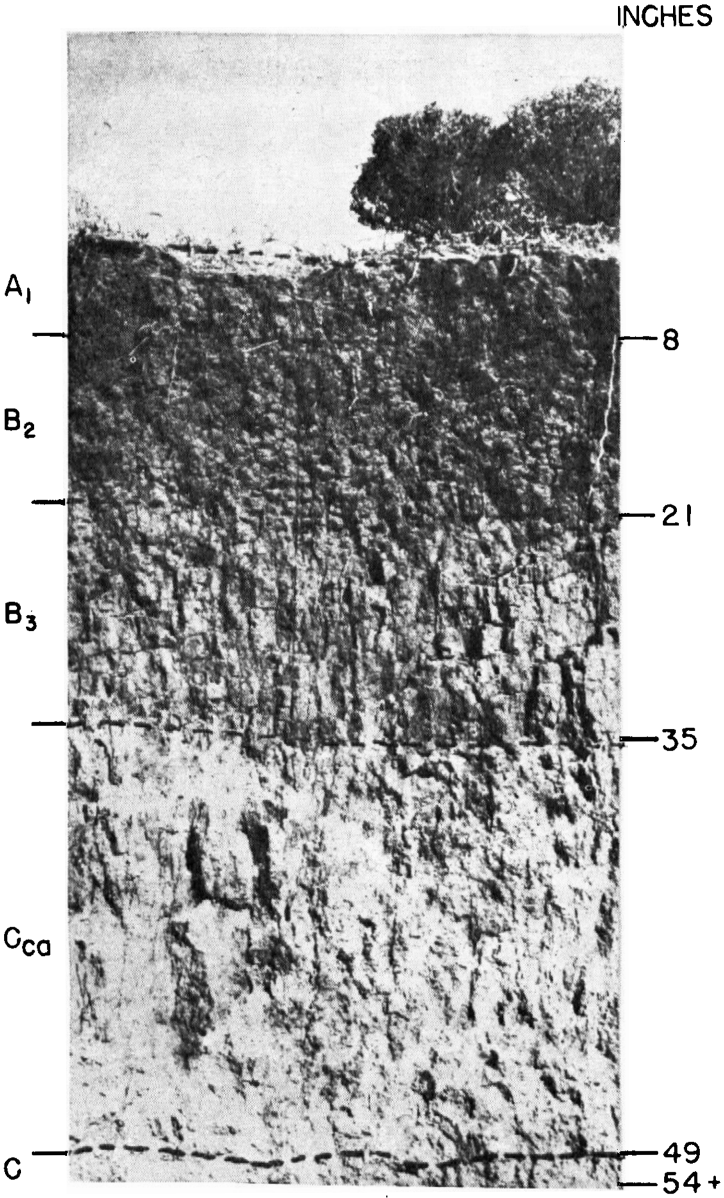

Figure 12.—**Profile of a Pullman soil.**

shallower; and the Ulysses, which are very friable and are calcareous to the surface.

The native vegetation consists mainly of such short grasses as buffalograss and blue grama. Since the Pullman soils are highly productive, most of them are in cultivation.

Profile description (cultivated area, approximately 1,500 feet southeast of the northwest corner of section 38, block 2, T.T. RR. Survey, about 50 feet northwest of fence, or about 0.75 mile east of Panhandle):

A_p 0 to 7 inches, dark grayish-brown (10YR 4/2; 3/2, moist) silty clay loam; weak, fine, subangular blocky and granular structure; friable when moist, hard when dry; roots common; noncalcareous; abrupt boundary.

B_{21} 7 to 17 inches, dark-brown (10YR 4/3; 3/3, moist) clay; moderately strong, medium, blocky structure; sticky and plastic when wet, very hard when dry; few, very fine pores and biological channels; flattened roots are mainly between peds; clay films nearly continuous on ped surfaces; noncalcareous; gradual boundary.

B_{22} 17 to 33 inches, dark-brown (7.5YR 4/2; 3/2, moist) clay; strong, medium, blocky structure; very sticky and plastic when wet, extremely hard when dry; prominent clay films; most roots are between peds and are flattened; slightly calcareous in the lower 5 inches; gradual boundary.

B_{ca} or B_{23} 33 to 48 inches, dark-brown (7.5YR 4/2; 3/2, moist) clay; moderate, medium, blocky structure; firm when moist, very hard when dry; few, very fine biological channels; few, very fine to fine, soft and hard concretions of calcium carbonate that are mostly between vertical walls of peds; moderately to strongly calcareous; clear boundary.

B_{2b} 48 to 75 inches, reddish-brown (5YR 5/3; 4/3, moist) silty clay; moderate, medium, blocky structure; firm when moist, very hard when dry; contrasting white blotches, mostly of soft calcium carbonate, and mainly between vertical walls of peds; also few, false mycelia are on and within the normal peds; weakly calcareous; abrupt boundary.

C_{cab} 75 to 95 inches +, pinkish-white (5YR 8/2; 8/3, moist) silty clay; friable when moist, hard when dry; about 40 percent of the volume is mostly soft concretions of calcium carbonate interspersed in earthen material; very strongly calcareous.

The texture of the A horizon ranges from dark-brown to dark grayish-brown, light clay to clay loam in cultivated fields. The thickness ranges from 5 to 8 inches. The difference is largely caused by wind and water erosion. On long, gentle slopes these soils have an occasional shallow, crossable gully. The dark-brown to dark grayish-brown, blocky clay B horizon is from 30 to 64 inches thick. A buried soil horizon (B_{2b}) commonly occurs. The depth to the C_{cab} horizon ranges from 36 to 70 inches or more and averages about 55 inches.

Pullman silty clay loam, 0 to 1 percent slopes (PuA).—This soil has the profile described as typical of the Pullman series. Included with this soil are areas of Ulysses clay loam and Zita clay loam, 1 to 5 acres in size. Also, in large areas of this soil there are inclusions of very gently sloping Pullman silty clay loam and Pullman silty clay loam, 1 to 3 percent slopes, eroded. These inclusions are 3 acres, or less, in size. Inclusions of areas of Randall clay, less than 3 or 4 acres in size, are shown on the map by depressional symbols. These areas contain water most of the time.

Nearly all of this soil is in crops. It is one of the most resistant soils to wind and water erosion in the county. When moisture is favorable under dryland farming, good to excellent crops are produced. Yields are also good to excellent if the soil is properly managed under irrigation. (Capability unit IIs–1 (irrigation); capability unit IIIce–1 (dryland farming); Hardland range site.)

Pullman silty clay loam, 1 to 3 percent slopes (PuB).—This soil occurs where playas and McClellan Creek have influenced the topography of the High Plains. The dominant slope is from 1 to 2 percent. A typical mapped area occurs as a broad band that has a convex slope and surrounds a larger playa.

This soil has a profile similar to that of the nearly level Pullman soil, except that the buried soil is normally absent where slopes are 2 to 3 percent. The profile color in places is slightly redder. The hue of the B horizon

ranges from 10YR to 5YR, but in the nearly level Pullman soil, the color is mostly dark brown, 10YR hue.

In places this soil includes eroded areas less than 3 to 4 acres in size. Areas of Ulysses clay loam, 1 to 3 percent slopes, and Zita clay loam, 1 to 3 percent slopes, less than 5 acres in size, and small areas of Pullman silty clay loam with slopes of slightly more than 3 percent are also included.

This soil is well suited to crops. Most of it is in cultivation. If moisture is favorable, or if the soil is properly irrigated, it is very productive. Water erosion is a constant but minor hazard. (Capability unit IIIe-1 (dryland farming or irrigation); Hardland range site.)

Pullman silty clay loam, 1 to 3 percent slopes, eroded (PuB2).—This soil generally has convex slopes of 2 to 3 percent. Around playas and on the sides of the drainageway of McClellan Creek on the High Plains, however, slopes range from 1 to 4 percent. Here, through misuse and lack of protection, about one-half of the surface soil has been removed, mainly by sheet erosion.

The dark-brown to dark grayish-brown, light clay to silty clay A_1 horizon ranges from 1 to 5 inches in thickness and averages about 3 inches. In places a part of the B_{21} horizon has been mixed by tillage with the A_1 horizon. Shallow, crossable gullies are common. In a few places gullies that are not crossable occur. These gullies have penetrated deeply into the solum.

The brown, very slowly permeable, blocky clay B horizon ranges from 20 to 40 inches or more in thickness. The depth to the C_{ca} horizon ranges from 24 to 50 inches but is mostly about 35 inches. In a few places, small areas (less than 3 acres in size) of eroded Ulysses soil are included with this soil. (Capability unit IVe-1 (dryland farming); Hardland range site.)

Randall Series

The Randall series consists of dark-gray, very poorly drained, clayey soils in depressions or low playa bottoms. These soils are deep and generally consist of noncalcareous, massive clay. They have formed from sediment washed from the surface of surrounding soils within the individual playa watershed. During wet seasons, these soils in larger playas are under water for long periods. They are unsuited to cultivation unless some of the outside water is diverted or the playa can be drained.

The vegetation consists chiefly of buffalograss, western wheatgrass, sedge, and some fireweed. During very wet years, drowning kills all vegetation except sedge and fireweed.

These soils under native short grasses and sedge have a characteristic micromounded and pit relief (gilgai). This relief is caused by swelling and shrinking of the soil. A part of the dry, dark, friable surface soil sloughs, washes, or falls into the deep shrinkage cracks before the cracks close by swelling. When the soil dries again, more surface soil falls or washes into the cracks. Thus, there is a slow circulation of the entire soil mass.

The main associated series is the Lofton, which is browner but has a surface soil of coarser texture and is better drained and better developed than the Randall soils. It is usually on higher benches or terraces that surround Randall clay.

Profile description (in a playa about 1.5 miles east of Panhandle on the southeast side of section 38, block 2, T. T. RR. Survey):

A_1 0 to 36 inches, dark-gray (N 4/0; 3/0, moist) clay; weak, fine and medium, blocky to massive structure; very sticky when wet, firm when moist, very hard to extremely hard when dry; deposits of silty clay loam in surface 2 inches; noncalcareous; gradual boundary.

AC_1 36 to 60 inches, dark grayish-brown (2.5Y 4/2; 3/2, moist) clay; massive structure; very sticky and plastic when wet, firm when moist, extremely hard when dry; some distinct mottles and characteristic musky odor when wet; noncalcareous; gradual boundary.

AC_2 60 to 73 inches, grayish-brown (2.5Y 5/2; 4/2, moist) clay; sticky when wet, firm when moist; a few, distinct coatings of dark reddish brown (5YR 3/4); noncalcareous except for a few films of calcium carbonate; gradual boundary.

C 73 to 85 inches +, light brownish-gray (10YR 6/2; 5/2, moist) light clay; sticky when wet, friable when moist; noncalcareous except for a few films and coatings of calcium carbonate.

The color of the solum ranges from gray to dark grayish brown. The hue is mostly 2.5Y, but in places it is 10YR and has a value of 4 to 5 and a chroma of 0 to 2. When wet, the soils have mottles in places and a characteristic musky odor. Although generally noncalcareous, these soils of the lakebeds include some areas of calcareous clay of the same color and consistence as that described.

Randall clay (Ra).—This soil has the profile described as typical of the Randall series. (Capability unit VIw-1; Hardland range site.)

Richfield Series

The Richfield series consists of deep, dark, moderately fine textured soils. These soils are smooth and nearly level to gently sloping. They formed in old calcareous alluvium or plains outwash, mainly under blue grama, buffalograss, and similar short grasses.

In recent years mesquite trees have taken over some of these hardland soils. Although the Richfield soils are very productive if moisture is adequate, they are still used as native rangeland within large cattle ranches.

The Richfield soils are associated with the Dalhart, which are slightly redder, lighter textured, and more permeable, and which have a weaker structure.

Profile description (virgin soil on 6666 Ranch, 100 yards south of windmill, 0.5 mile east and 15 miles north of Panhandle):

A_1 0 to 7 inches, very dark grayish-brown (10YR 3/2; 2/2, moist) clay loam; weak to moderate, medium, granular structure; very friable when moist, slightly hard when dry; many roots; few wormcasts; upper 1 inch is accumulation of dark grayish-brown, weak, thin, platy clay loam; noncalcareous; gradual, smooth boundary.

B_1 7 to 18 inches, dark grayish-brown (10YR 4/2; 3/2 moist) light clay; moderate, medium and fine, subangular blocky structure; friable when moist, hard when dry; roots common; few, fine biological pores and channels; noncalcareous; gradual boundary.

B_{21} 18 to 32 inches, dark grayish-brown (10YR 4/2; 3/2, moist) clay; moderate, medium, blocky structure; sticky when wet, firm when moist, very hard when dry; flattened roots commonly occur between peds; prominent clay films continuous on ped surfaces; few, fine and very fine root channels and pores; noncalcareous to weakly calcareous in lower part; clear boundary.

B_{22} 32 to 42 inches, grayish-brown (10YR 5/2; 4/2, moist) clay; moderately strong, medium, blocky structure; sticky when wet, very hard when dry; few, fine, soft and hard concretions of calcium carbonate; few, fine and very fine biological pores and channels; weakly calcareous; clear boundary.

B_{23} 42 to 54 inches, grayish-brown (10YR 5/2; 4/2, moist) light clay; moderate to weak, medium, blocky to subangular blocky structure; hard when dry; few, fine and very fine biological pores and channels; few, fine to medium, soft and hard calcium carbonate concretions; strongly calcareous; clear boundary.

C_{ca} 54 to 72 inches, very pale brown (10YR 7/3; 6/3, moist), very strongly calcareous sandy clay material consisting of about one-third segregated calcium carbonate and two-thirds light-brown earthen material; diffuse boundary.

C 72 to 84 inches +, pale-brown (10YR 6/3; 5/3, moist) sandy clay loam with less segregated lime than in the C_{ca} horizon.

The moderately permeable clay loam A_1 horizon ranges from 5 to 8 inches in thickness and from dark brown to very dark grayish brown in color, hue 10YR, value 3 to 4, chroma 2. The very slowly permeable, blocky clay B horizon ranges from about 30 to 60 inches in thickness and mostly from dark brown to dark grayish brown in color, hue 10YR. The depth to the C_{ca} horizon ranges from 36 to 54 inches, and the thickness ranges from about 10 to 18 inches.

Richfield clay loam, 1 to 3 percent slopes (RcB).—This soil has the profile described for the Richfield series. It typically occurs on slopes of somewhat less than 2 percent. Small areas with slopes of less of than 1 percent are included. (Capability unit IIIe-1 (dryland farming or irrigation); Hardland range site.)

Rough Broken Land

Rough broken land (Ro).—This land type has developed in strongly calcareous deposits of the erosional plains. It occurs on sloping to steeply sloping caliche escarpments and subdued escarpments that border the High Plains. Many of the remnant escarpments are abrupt, steep valley walls or tonguelike ridges, hills, and subdued buttes that extend 8 to 12 or more miles into the Rolling Plains. Because of the rugged relief and exposure, little or no soil has developed.

The sparse, patchy cover of side-oats grama and catclaw provides little or no grazing for livestock. It frequently does give refuge to antelope, bobcats, coyotes, snakes, and other wildlife. (Capability unit VIIs-1; Rough Breaks range site.)

Rough Stony Land

Rough stony land (Rs).—This land type is inextensive but rugged and scenic. It occurs mostly near where the West Fork of Dixon Creek joins Dixon Creek. Through geologic erosion, these creeks have removed all of the High Plains sediment. They have penetrated the hard limestone and cut deeply into the soft, red sandstone and gypsum beds.

The highly resistant limestone stratum forms another very prominent, steep, jagged escarpment. Flagstones that are less than a foot to more than 6 feet thick, some weighing many tons, break off this escarpment and partly mantle the talus red-bed materials below.

There are minor inclusions of Gravelly rough land and of soils similar to those of the Quay series. Quay soils are not mapped in Carson County. Except for these inclusions, little or no soil has formed on the nearly inaccessible slopes. The native vegetation is generally sparse and consists mostly of little and tall bluestem, side-oats, hairy and blue grama, and some juniper and catclaw shrubs. (Capability unit VIIs-1; Rough Breaks range site.)

Riverwash

Riverwash (Rw).—This mapping unit consists of fresh, unstable deposits of variably textured material, mainly loose sands with some gravel. It supports little or no vegetation. Since it has a small acreage and no agricultural value, Riverwash has not been classified for range site or capability unit.

Spur Series

The Spur series consists of dark, deep, calcareous bottom-land soils that are made up of fine- and medium-textured alluvium. The alluvium came from higher lying, adjacent Pullman, Ulysses, Berthoud, Mansker, and Bippus soils. The Spur soils are usually on nearly level, low areas above drainage channels of the larger draws and small valleys in the Rolling Plains. In some places the cutting of the stream channel is so active and deep that the streams rarely overflow their banks. A profile of a Spur soil is shown in figure 13.

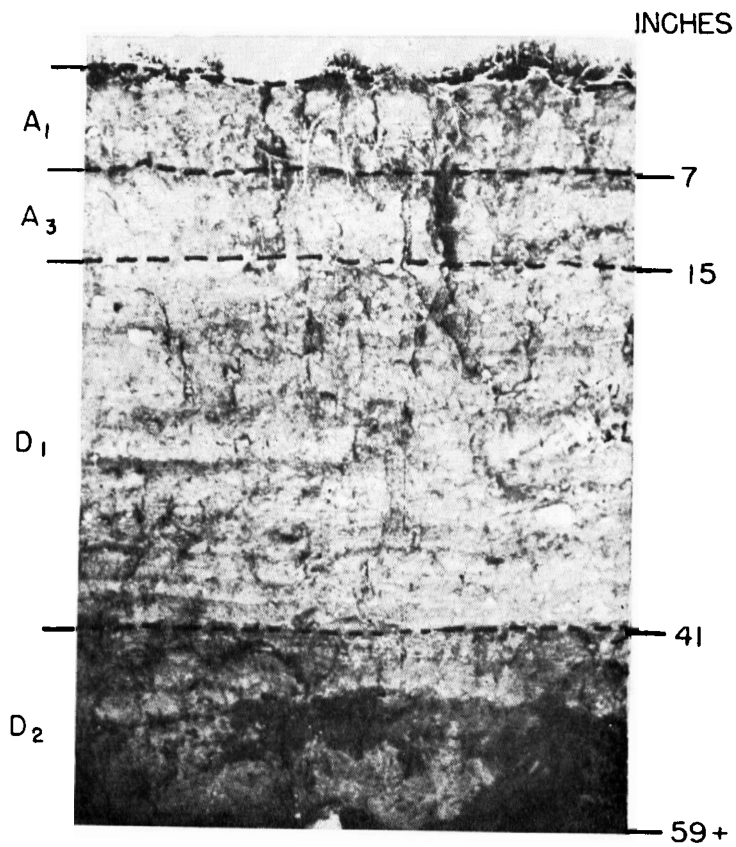

Figure 13.—Profile of a Spur soil.

The associated Bippus soils are slightly more sloping but less stratified than the lower lying Spur clay loam or Spur fine sandy loam.

Spur soils are generally arable but are used mainly for native range. They are productive, but because of channel cutting, many small, isolated areas cannot be used for crops. Elsewhere, damaging stream overflow makes these soils unsuited to cultivation but does not prevent their use for range.

The native vegetation consists mainly of buffalograss and blue grama on the clay loam. Bluestem, sand dropseed, and sand sagebrush replace the buffalograss on the sandier soils. Native elm or hackberry trees grow in places where springs occur on the banks of some of the major intermittent streams.

Profile description (undisturbed area, 7,200 feet west and 2,240 feet south of the northeast corner of Carson County):

A_{11} 0 to 5 inches, dark grayish-brown (10YR 4/2; 2/2, moist) clay loam; moderate, medium, prismatic structure and granular structure; friable when moist, hard when dry; wormcasts and roots common; noncalcareous; gradual boundary.

A_{12} 5 to 13 inches, dark grayish-brown (10YR 4/2; 3/2, moist) clay loam; moderate, medium, prismatic structure and granular structure; friable when moist, hard when dry; many roots and wormcasts; few, fine biological pores and channels; slightly calcareous; clear boundary.

AC 13 to 22 inches, dark-brown (7.5YR 4/2; 3/2, moist) clay loam; structure and consistence similar to those in horizon above; roots common; many wormcasts; few, fine biological pores and channels; strongly calcareous; clear boundary.

C 22 to 72 inches +, light-brown (7.5YR 6/4; 5/4, moist) light clay or clay loam; moderate, fine, subangular blocky structure; friable when moist, very hard when dry; few roots in upper part; few, false mycelia on ped surfaces; strongly calcareous and stratified.

The thickness of the A horizon ranges from 8 to 18 inches. The texture is mostly clay loam but ranges from silty clay loam to sandy clay loam. The texture of the subsoil ranges from light clay to sandy clay loam. Clay loam is the most common. The color of the surface soil ranges from very dark grayish brown (10YR 3/2; 2/2, moist) to dark brown (7.5YR 4/2; 3/2, moist). That of the subsoil ranges from dark grayish brown (10YR 4/2; 3/2, moist) to dark brown (7.5YR 4/3; 3/3, moist).

Generally, the profile is weakly developed and stratified. One or more buried soil horizons are common. In a few places, deep, vertical stream gullies have exposed buried soil profiles at a depth of 5 to 15 feet.

Spur clay loam (Sc).—This soil has the profile described as typical of the Spur series. In most places it is calcareous at or near the surface. It is very productive and arable. It occurs mostly on the alluvial plains paralleling the larger stream courses in the Rolling Plains.

Small areas of Bippus clay loam are included. In places these inclusions comprise 5 to 10 percent of the soil. (Capability unit IIe–1 (irrigation); Capability unit IIIce–2 (dryland farming); Hardland range site.)

Spur fine sandy loam (Sp).—This is a more arable, sandier soil than Spur clay loam. It is less calcareous in the surface soil and slightly more permeable in the subsoil. In places it is noncalcareous to a depth of 25 inches or more. The profile of this soil is usually not so dark and is less well developed than that of Spur clay loam.

This productive soil is used to grow supplemental livestock feed in only two small areas. The rest of the soil is used as native range. (Capability unit IIIe–3 (dryland farming); capability unit IIe–2 (irrigation); Mixed Land Slopes range site.)

Tivoli Series

The Tivoli series consists of light-colored, deep, loose, very immature sandy soils. The only significant area in the county occurs on sandhills in the north-central part, between Dixon Creek and Spring Creek. The Tivoli soils have formed in a regular pattern of wind-deposited sand dunes and ridges. The only sign of soil development is a slight accumulation of organic matter that normally darkens the surface soil. Vegetation stabilizes and protects most areas from wind erosion. Few blowouts occur, but a few ridges are bare and actively eroding. Since these soils absorb all of the precipitation received, they help recharge the water table.

Associated soils are the Likes, which are more developed, less sandy, and not dominantly wind deposited; and the Vona, which are deep, mature, medium textured, and arable.

The vegetation consists largely of sand bluestem, Indiangrass, big sandreed, and other deep-rooted grasses. There is some blue grama that is not quite so deeply rooted. Sand sagebrush, a low, deep-rooted shrub, is common. In scattered places are yucca, skunkbush, and wild plum. When properly managed, much of the area of these soils has an optimum vegetative cover of 20 to 30 percent. Although the carrying capacity is fairly low, it is higher than that of the heavier textured soils during droughts. The Tivoli soils are susceptible to severe blowing; therefore, much more care is required to prevent overgrazing on these soils than on other rangeland soils.

Profile description (on the 6666 Ranch, 0.6 mile west of Bear Creek and 0.1 mile south of the Hutchinson and Carson County line):

A 0 to 8 inches, pale-brown (10YR 6/3; 5/4, moist) fine sand; single-grained structure; loose when dry; extremely porous; few roots; noncalcareous; diffuse boundary.

C 8 to 72 inches +, light yellowish-brown (10YR 6/4; 5/4, moist) stratified fine sands and sands that are noncalcareous; roots extend many feet into this layer.

The A horizon ranges from 4 to 12 inches in thickness. It ranges from pale brown to brown in color but is mostly pale brown. The C horizon ranges from brown to pale brown, hue 10YR, value 5 to 6, chroma 3 to 4. Weakly calcareous material occurs at a depth of 24 to 50 inches, but in most places no free lime is present to a depth of 72 inches.

Tivoli fine sand (Tv).—This soil is on stabilized dunes that are about 200 feet or more in diameter and from 5 to 30 feet in height. Before the dunes were stabilized, they were moving toward the northeast.

Minor inclusions of the Vona soil are in lower swales between the dunes. These areas make up about 15 percent of this soil.

Tivoli fine sand is subject to very severe wind erosion. (Capability unit VIIe-1; Sandy Land range site.)

Ulysses Series

The Ulysses series consists of well-drained, youthful soils that are calcareous and loamy. These soils formed mainly in loessal High Plains deposits. They occur in scattered areas, mostly on flattened ridges or knolls surrounded by Pullman soils and along the steeper slopes of playas and interstream draws. A profile of a Ulysses soil is shown in figure 14.

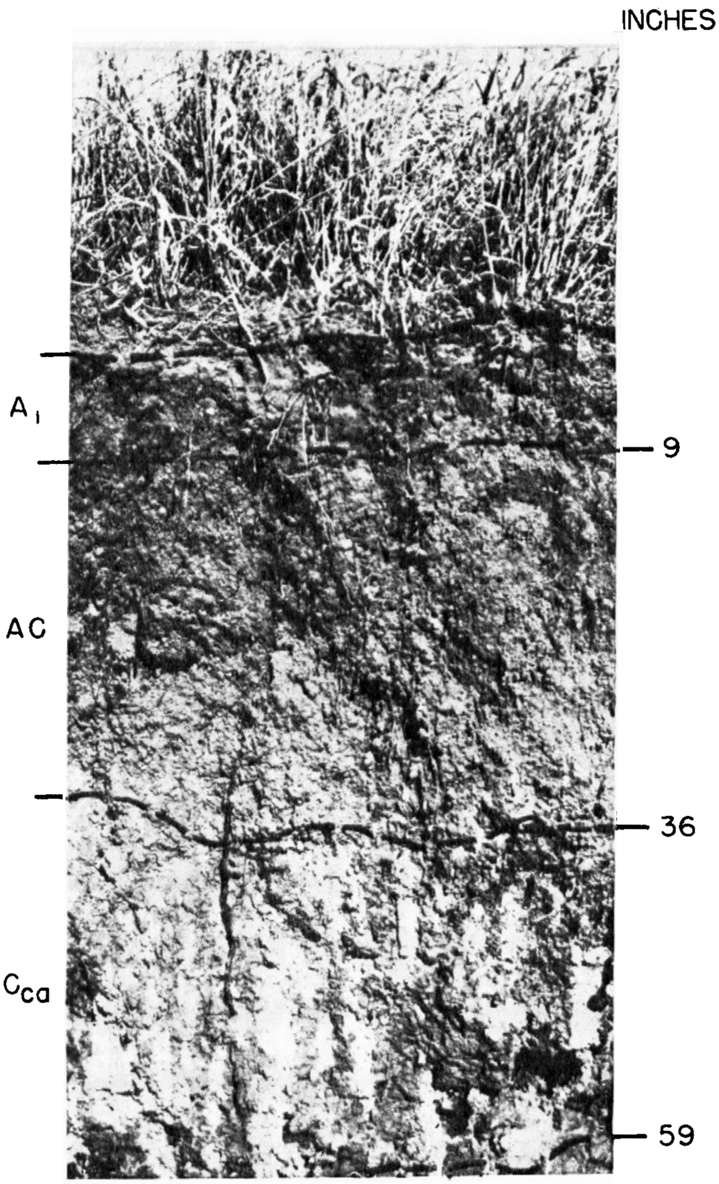

***Figure 14.*—Profile of a Ulysses soil.**

The Ulysses soils are similar to Mansker soils in color and reaction, but they are deeper and show slightly more structural development in the subsoil. They are more friable, lighter colored, less clayey, and less developed structurally than the Pullman or Richfield soils.

The native vegetation consists mainly of blue grama and some side-oats grama and buffalograss. The more gentle slopes of these soils are mostly cultivated to wheat and sorghum. In some seasons chlorosis reduces yields of sorghum. If these soils are not protected by crop residues when cultivated, they are more susceptible to blowing than the associated Pullman soils.

Profile description (1,600 feet west of the southeastern corner of section 2, block M 4, J. H. Gibson Survey, 5.3 miles west of Panhandle):

A_1 0 to 8 inches, grayish-brown (10YR 5/2; 4/2, moist) light clay loam; weak, fine, granular structure; slightly sticky when wet, very friable when moist; common to many fine pores and roots; wormcasts few to common; surface 1 inch is recent deposit of silt loam material; calcareous; gradual boundary.

AC 8 to 25 inches, brown (7.5YR 5/2; 4/2, moist) clay loam; moderate, coarse, prismatic structure that easily breaks to moderate, fine, granular; slightly sticky when wet, friable when moist; many wormcasts; many fine biological pores and channels; many roots readily penetrate this layer; strongly calcareous; gradual boundary.

C_{ca} 25 to 40 inches, brown (7.5YR 5/4; 4/4, moist) light clay loam; moderate, fine, subangular blocky structure; slightly sticky when wet, hard when dry; wormcasts and roots common; many fine pores and channels; strongly to very strongly calcareous; fine, soft concretions of calcium carbonate common in lower part; gradual boundary.

C 40 to 65 inches +, light reddish-brown (5YR 6/4; 5/4, moist) clay loam; slightly sticky when wet, slightly hard when dry; fine pores and channels common; strongly calcareous; a few, soft concretions of calcium carbonate in upper part.

The A_1 horizon ranges mostly from brown to grayish brown, hue 10YR, value 3 to 5, chroma 2 to 4, and from silt loam to silty clay loam. The thickness ranges from 7 to 10 inches.

The AC horizon ranges from dark brown to light brown, hue, 10YR to 7.5YR, value 3 to 5, chroma mostly 2. The thickness of this horizon ranges from 14 to 28 inches and averages about 20 inches.

The C_{ca} horizon is generally weak and not too well defined. It ranges from light yellowish brown to pink, hue 10YR to 7.5YR, value 6 to 7, chroma 4, and ranges from porous clay loam to silty clay loam in texture. The depth ranges from 20 to 45 inches. From less than 10 percent to as much as 50 percent of the volume is mostly soft concretions of calcium carbonate.

The C horizon, or parent material, ranges from mostly brown to occasionally reddish yellow, hue 7.5YR to 5YR, value 5 to 6, chroma 4, and ranges from clay loam to silty clay loam in texture. A few, mostly soft concretions of calcium carbonate are scattered throughout the C horizon.

Ulysses clay loam, 0 to 1 percent slopes (UcA).—This soil is less sloping and darker and has a slightly thicker profile than Ulysses clay loam, 1 to 3 percent slopes. It is a transitional soil that occurs between the nearly level Pullman and the gently sloping Mansker soils. (Capability unit IIe-1 (irrigation); capability unit IIIce-2 (dryland farming); Hardland range site.)

Ulysses clay loam, 1 to 3 percent slopes (UcB).—This soil is more representative of the series than Ulysses clay loam, 0 to 1 percent slopes. It is largely confined to an area northwest of Panhandle where it is associated with Pullman and some Zita soils. It characteristically occupies smooth, somewhat flattened, convex knolls and ridges that rise 1 to 20 feet above the surrounding plain. Smaller areas shaped as narrow bands are on slopes above and around the playa benches and the steeper slopes of McClellan Creek in the High Plains.

The most common inclusions are small areas of Mansker and Zita soils that comprise less than 10 percent of this soil. (Capability unit IIIe-2 (dryland farming or irrigation); Hardland range site.)

Ulysses clay loam, 1 to 3 percent slopes, eroded (UcB2).—Although inextensive, this soil is significant in the agriculture of the county. Improper management and lack of adequate cover have allowed loss of 25 to 75 percent of the original A horizon through wind erosion, and a lesser amount through water erosion. Except for the loss of much of the surface soil through erosion, and the resulting lower productivity, this soil is similar to Ulysses clay loam, 1 to 3 percent slopes. Small included areas (less than 5 acres in size) of Mansker clay loam may comprise as much as 7 percent of some of the mapped areas of this soil. (Capability unit IVe-1 (dryland farming); Hardland range site.)

Vona Series

The Vona soils are sandy, generally deep, well drained, and noncalcareous. They formed on fairly recent sandy geologic deposits that have been reworked by wind in places. These soils have enough silt and clay to make them slightly coherent. They occur mostly along draws and undulating flats between Spring and Dixon Creeks.

Associated with the Vona soils is Tivoli fine sand, which is structureless and mostly on dunelike relief. Also associated is Likes loamy fine sand, hummocky, which is generally calcareous, less developed, and lighter in color and texture throughout the profile than the Vona soils.

The vegetation consists chiefly of blue grama, some bluestem, and sand dropseed. Sand sagebrush is common. Because of rapid permeability, most of the precipitation is absorbed. The water is available to growing plants and recharges the water table. Although all of these soils are still in native grass, they produce fairly good row crops if they are carefully managed to prevent blowing.

Profile description (about 2,200 feet east of where Texas Highway No. 152 crosses the Hutchinson and Carson County line, thence 350 feet south on west side of ranch road):

A_1 0 to 9 grayish-brown (10YR 5/2; 4/2, moist) to brown (10YR 5/3; 4/3, moist) fine sandy loam; weak, fine, granular structure approaching single grained; loose and porous; roots, worm and insect burrows and casts common; noncalcareous; gradual boundary.

B_1 9 to 24 inches, brown (10YR 5/3; 4/3, moist) friable fine sandy loam or light fine sandy clay loam; weak, very coarse, prismatic structure that easily breaks to weak, fine and medium, granular; roots common; worm and insect burrows and casts common; noncalcareous; diffuse boundary.

B_2 24 to 48 inches, yellowish-brown (10YR 5/4; 4/4, moist) fine sandy loam or light fine sandy clay loam; compound structure—moderate, very coarse, prismatic and moderate, medium, granular; very friable when moist, hard when dry; biological activity becomes less common with depth; weakly to strongly calcareous; diffuse boundary.

C_1 48 to 108 inches +, light yellowish-brown (10YR 6/4; 5/4, moist), weakly stratified fine sandy loam and loamy fine sand; practically structureless but generally calcareous throughout.

The grayish-brown to dark-brown (hue 10YR, value 4 to 5, chroma 2 to 3) A horizon is fine sandy loam that ranges from 8 to 18 inches in thickness but averages about 10 inches. The B horizon ranges from 22 to 40 inches in thickness but averages 30 inches. Its dry color is mostly brown but ranges from dark brown to yellowish brown, hue 10YR, value 3 to 5, chroma 3 to 4. Texture ranges from fine sandy loam to light sandy clay loam. Free calcium commonly occurs at a depth of 2 to 3 feet, but in a few places little or none is noticeable to a depth of 6 feet. The depth of the materials reworked by wind ranges from 2 to 4 feet or more.

Vona fine sandy loam, 1 to 3 percent slopes (VoB).—This soil has the profile described as typical of the Vona series. (Capability unit IIIe-3 (dryland farming or irrigation); Mixed Land range site.)

Zita Series

The Zita series consists of deep, brown to very dark grayish-brown, permeable loamy soils. Prominent deposits of caliche occur in the subsoil below about 30 inches. These soils formed in the lighter or more friable, calcareous silty earths originating from loess or other windblown material. They occur on very gently sloping areas and slightly concave or level plains that border playas. Scattered areas are on drainageways on the High Plains. A profile of a Zita soil is shown in figure 15.

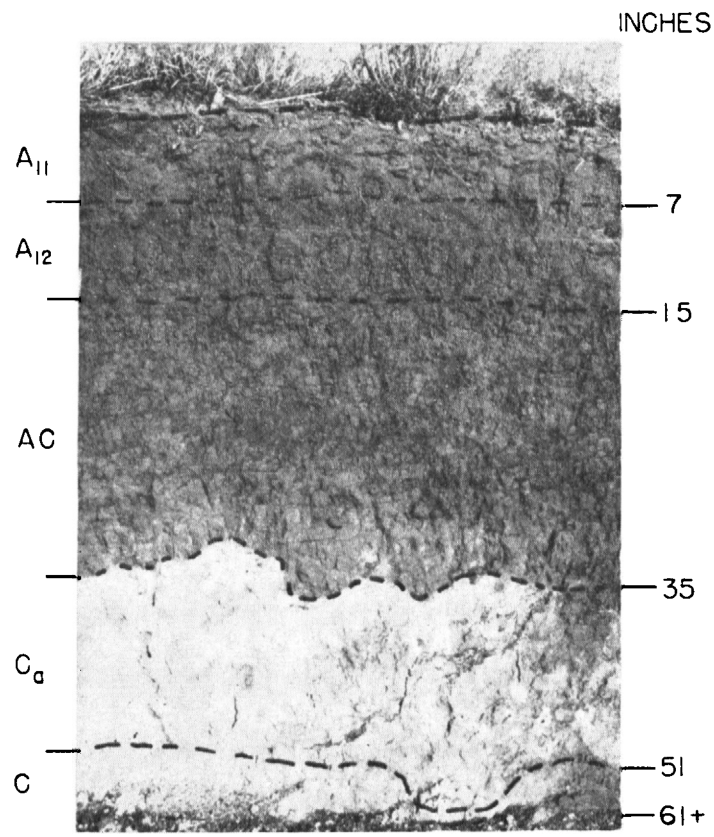

Figure 15.—**Profile of a Zita soil.**

The main associated soils are Pullman, which are heavier and less permeable in the subsoil; and Ulysses, which are lighter colored and calcareous throughout the profile.

The native vegetation consists mainly of mid and short grasses, such as blue grama, side-oats grama, scatterings of little bluestem, and buffalograss.

Profile description (in a cultivated field, 0.5 mile east and 0.8 mile north of the southeast corner of section 43, block 4 M, J. H. Gibson Survey, about 4 miles east-southeast of St. Francis):

A_p 0 to 8 inches, dark grayish-brown (10YR 4/2; 3/2, moist) clay loam; structureless but contains a mixture of weak, fine and medium, granular material from the lower horizon; slightly sticky when wet, very friable when moist; noncalcareous; abrupt boundary.

A_{12} 8 to 22 inches, very dark grayish-brown (10YR 3/2; 2/2, moist) silty clay loam; moderately strong, fine, subangular blocky and granular structure; moderately sticky when wet, very friable when moist, slightly hard when dry; many wormcasts that comprise as much as three-fourths of the soil mass; many fine biological channels, pores, and some fine roots; noncalcareous; gradual boundary.

AC 22 to 38 inches, grayish-brown (10YR 5/2; 4/2, moist) light silty clay loam; moderate, fine, subangular blocky and fine, granular structure; sticky when wet, friable when moist, hard when dry; fine and very fine biological pores; channels and roots common; many wormcasts; few, false mycelia; fine, soft concretions of calcium carbonate; weakly to strongly calcareous; clear boundary.

C_{ca} 38 to 63 inches, light-gray (10YR 7/1; 6/1, moist) fine sandy clay loam; moderately strong, medium, granular structure; sticky when wet, friable when moist, moderately hard when dry; many, fine and medium, soft and hard concretions of calcium carbonate; very strongly calcareous; about 40 percent by volume is soft and hard concretions of calcium carbonate; gradual boundary.

D 63 to 80 inches +, reddish-yellow (5YR 6/6; 5/6, moist) clay; firm when moist, very hard when dry; few, fine to medium concretions of calcium carbonate; few, very fine root channels; strongly calcareous.

The soil color is largely influenced by organic matter and ranges from dark grayish brown (10YR 4/2; 3/2, moist) to very dark grayish brown (10YR 3/2; 2/2, moist). The texture of the A horizon is generally clay loam but ranges from clay loam to fine sandy loam. The thickness of this horizon ranges from 7 to 24 inches but averages about 20 inches. The AC horizon ranges from 9 to 22 inches in thickness but averages about 18 inches. A very prominent, chalky C_{ca} horizon is at depths of 24 to 48 inches but is generally at depths of 26 to 36 inches.

Zita clay loam, 0 to 1 percent slopes (ZcA).—This soil has the profile described as typical of the Zita series. It formed on a smooth, nearly level, slightly concave plain or on benches extending between the Lofton and the gently sloping Pullman or Dalhart soils.

Inclusions that consist mostly of Zita fine sandy loam, 0 to 1 percent slopes, and minor amounts of Lofton silty clay loam, 0 to 1 percent slopes, make up about 15 percent of this soil. The inclusions are in the border areas of this soil.

This highly productive soil is well suited to either dryland or irrigated crops. (Capability unit IIe–1 (irrigation); capability unit IIIce–2 (dryland farming); Hardland range site.)

Zita clay loam, 1 to 3 percent slopes (ZcB).—This soil generally has a thinner profile than Zita clay loam, 0 to 1 percent slopes. It appears on slightly stronger slopes along the upper and lower rims of playas and along McClellan Creek. This soil has minor inclusions (less than 5 percent of the mapped areas) of Lofton and Pullman soils with slopes of less than 2 percent. Zita clay loam, 1 to 3 percent slopes, is a very productive and fertile soil and is well suited to cultivation and grass production. (Capability unit IIIe–2 (dryland farming or irrigation); Hardland range site.)

Use and Management

In this section the system of land capability classification used by the Soil Conservation Service is briefly explained. The soils are placed in capability groups, and the management for each group is discussed. General management is also discussed, and estimated average acre yields are given for the soils under two levels of management. Separate sections on management of rangeland, farmstead windbreaks, and wildlife areas are included.

Capability Groups of Soils

The capability classification is a grouping of soils that shows, in a general way, how suitable they are for most kinds of farming. It is a practical grouping based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment.

In this system all the kinds of soil are grouped at three levels, the capability class, subclass, and unit. The eight capability classes in the broadest grouping are designated by Roman numerals I through VIII. In class I are the soils that have few limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, grazing, or wood products. There are no class VIII soils in Carson County.

The subclasses indicate major kinds of limitations within the classes. Within most of the classes there can be up to four subclasses. The subclass is indicated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* means that water in or on the soil will interfere with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the country, indicates that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have a few or no limitations. Class V can contain, at the most, only subclasses *w*, *s*, and *c*, because the soils in it have little or no susceptibility to erosion but have other limitations that limit their use largely to pasture, range, woodland, or wildlife.

Within the subclasses are the capability units, groups of soils enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping of soils for making many statements about their management. Capability units are generally identified by numbers assigned locally, for example, IIe–1 or IIIe–2.

Soils are classified in capability classes, subclasses, and

units according to the degree and kind of their permanent limitations; but without consideration of major and generally expensive land-forming that would change the slope, depth, or other characteristics of the soils; and without consideration of possible but unlikely major reclamation projects.

Capability classes in the system, and the subclasses and units in Carson County, are given in the following list. Because some of the hazards of climate are removed by irrigation, a few of the soils are in a more favorable capability class for irrigation than for dryland farming. The capability grouping is one that covers the soils of several counties, and there are some gaps in the numbering system when only the units of this county are listed.

Class I.—Soils that have few limitations that restrict their use. (None in the county.)

Class II.—Soils that have some limitations that reduce the choice of plants or require moderate conservation practices.

- Subclass IIe.—Soils that are subject to slight wind and water erosion if they are cultivated and not protected.
  - Capability unit IIe-1 (irrigation).—Deep, moderately permeable clay loams, nearly level, that have moderately permeable subsoils. (Dryland farming, IIIce-2.)
  - Capability unit IIe-2 (irrigation).—Deep, moderately to moderately rapidly permeable fine sandy loams, nearly level, that have moderately permeable subsoils.
- Subclass IIs.—Soils that are subject to slight wind and water erosion if they are cultivated and not protected.
  - Capability unit IIs-1 (irrigation).—Nearly level, deep soils that have silty clay loam surface soils and very slowly permeable subsoils. (Dryland farming, IIIce-1.)

Class III.—Soils that have severe limitations that reduce the choice of plants, require special conservation practices, or both.

- Subclass IIIe.—Soils that are subject to moderate erosion if they are cultivated and not protected.
  - Capability unit IIIe-1 (dryland farming or irrigation).—Deep, very slowly to slowly permeable clay loams to silty clay loams, gently sloping.
  - Capability unit IIIe-2 (dryland farming or irrigation).—Deep, slowly permeable clay loams, gently sloping.
  - Capability unit IIIe-3 (dryland farming or irrigation).—Deep, moderately to moderately rapidly permeable fine sandy loams, gently sloping.

Class IV.—Soils that have very severe limitations that restrict the choice of plants, require very careful management, or both.

- Subclass IVe.—Soils subject to moderately severe wind and water erosion if they are cultivated and not protected.
  - Capability unit IVe-1 (dryland farming).—Deep, moderately to very slowly permeable clay loams to silty clay loams, moderately sloping.
  - Capability unit IVe-2 (dryland farming or irrigation).—Deep to shallow, moderately to moderately rapidly permeable loams to fine sandy loams, moderately sloping.

Class V.—Soils that have little or no susceptibility to erosion but have other limitations, impractical to remove without major reclamation, that limit their use largely to pasture or range, woodland, or wildlife food and cover.

- Subclass Vw.—Soils that are subject to frequent overflow.
  - Capability unit Vw-1.—Deep, nearly level to cut-up bottom-land soils that are moderately to moderately rapidly permeable.

Class VI.—Soils that have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife food and cover.

- Subclass VIe.—Soils unsuited to cultivation because of extreme risks of wind and water erosion when tilled but suited to permanent grasses.
  - Capability unit VIe-1.—Deep to shallow, moderately permeable loams, moderately sloping to sloping.
  - Capability unit VIe-2.—Shallow to deep, calcareous sandy loams, moderately sloping to sloping.
- Subclass VIw.—Soils not suitable for cultivation because of flooding.
  - Capability unit VIw-1.—Deep, fine-textured soils in beds of intermittent lakes.

Class VII.—Soils that have very severe limitations that make them unsuitable for cultivation without major reclamation and that restrict their use largely to grazing or wildlife.

- Subclass VIIe.—Soils that are very severely limited because of extreme risks of wind erosion.
  - Capability unit VIIe-1.—Deep, billowy, coarse-textured, rapidly permeable soils.
- Subclass VIIs.—Land types and soils that are severely limited by physical characteristics.
  - Capability unit VIIs-1.—Stony, cobbly, and rough broken land.
  - Capability unit VIIs-2.—Very shallow, strongly sloping soils.

Management by Capability Units

In this section soils of the county that can be used and managed in about the same way are placed in a capability unit. A discussion of each unit follows.

CAPABILITY UNIT: IIe-1, IRRIGATION; IIIce-2, DRYLAND FARMING

This unit consists of deep, nearly level clay loams. These soils have a moderately permeable subsoil. They take water readily. It is not difficult to maintain normal movement of air, water, and roots in the soils. The hazard of wind erosion is slight to moderate. The soils in this unit are:

Spur clay loam.
Ulysses clay loam, 0 to 1 percent slopes.
Zita clay loam, 0 to 1 percent slopes.

Major management practices on these soils are (1) maintenance of cover, roughness, and cloddiness; and (2) conserving moisture.

Except for most of the scattered areas of Spur clay loam, the soils of this unit are largely used to produce winter wheat and grain sorghum. In some seasons young sorghum and corn plants are damaged by chlorosis. This is a deficiency plant disease, presumably caused by the tieup of iron and manganese by excessive lime. The plants may recover after rains, but yields will be reduced.

These friable soils are easy to manage. They take water at a moderate rate and have a moderate capacity to hold water and plant nutrients. If the Spur soil is cultivated, diversion terraces should be used to protect it from water from adjacent slopes.

Dryland farming.—Under dryland farming, management should include practices that will conserve the much needed moisture for production of crops and also protect the soil from wind erosion. Present practices are contour tillage and stubble-mulch tillage. If compacted layers develop, they should be broken by deep chiseling. Crop residue or a growing crop is required to protect these soils during the windy season. If crops fail to make a good stand, the surface of the soil should be roughened by chiseling or listing to bring up clods and trap the drifting soil. Crops should be planted as soon as there is enough moisture.

Irrigation.—Under irrigation these soils produce high yields of winter wheat, grain sorghum, cotton, alfalfa, and other crops commonly grown in the area. Sweetclover, rye, and sudangrass are also used for pasture and green manure. Higher crop yields may be obtained by applying barnyard manure and commercial fertilizer. The kinds and amounts of fertilizer used should be determined by soil tests and crop needs.

CAPABILITY UNIT: IIe-2, IRRIGATION

The soil in this unit has a deep, nearly level fine sandy loam surface layer. It has a sandy clay loam and clay loam subsoil that has moderate to moderately rapid permeability. The soil has a moderate capacity to hold water and plant nutrients. It takes water readily and is easy to manage. The soil in this unit is:

Spur fine sandy loam.

Major management practices are (1) maintenance of cover, roughness, and cloddiness; and (2) fertilizing the soil in amounts determined by soil and crop needs.

This soil is less susceptible to water erosion than to wind erosion. Some channel cutting occurs in places, however. The soil should therefore be protected from water from adjacent, steeper soils by diversion terraces. Under cultivation it is moderately susceptible to wind erosion.

Irrigation.—Under irrigation this soil is a good producer of crops commonly grown in the area, such as winter wheat, grain and feed sorghum, and alfalfa. Also, sweetclover, rye, and sudangrass are used to some extent for pasture and green manure. Much higher crop yields may be obtained by applying barnyard manure and commercial fertilizer. The kinds and amounts of fertilizer to use should be based on soil tests and crop needs.

CAPABILITY UNIT: IIs-1, IRRIGATION; IIIce-1, DRYLAND FARMING

This unit consists of soils that have a deep, smooth, and nearly level silty clay loam surface layer. They have very slowly permeable subsoil, which at times limits root development and impedes movement of air and water. Under range and dryland farming, these soils maintain high native fertility. They have a high moisture-holding capacity. Because of crusting of the surface soil, tightness of the subsoil, and the tendency of soil structure to deteriorate, very careful management is needed for production of moderate to high yields. The risk of wind erosion is slight in these soils. The Pullman soil is slightly susceptible to water erosion. The soils in this unit are:

Lofton silty clay loam.
Lofton and Church soils.
Pullman silty clay loam, 0 to 1 percent slopes.

Major management practices are (1) maintenance of cover, roughness, and cloddiness; (2) maintenance of optimum structure in surface soil and subsoil; and (3) conserving moisture.

Under cultivation these soils are productive. Winter wheat and grain and feed sorghums are the main crops.

If tilled when too moist, or if tilled continuously at the same depth, these deep, moderately fine textured soils often develop plowpans and compacted layers. Deep chiseling temporarily breaks up such plowpans and compacted layers and allows the deep-rooted plants to help recondition the damaged soils. Overtillage hastens the breakdown and effectiveness of crop residues and destroys the natural structure of the soils. A minimum amount of tillage should be used to kill weeds and prepare the seedbed, so that the structure of the surface soil and the crop residues are least disturbed.

Dryland farming.—Winter wheat and grain sorghum are most successfully grown on these soils in a cropping system suited to the climate. Wheat can be grown during years when there is 2 feet of wetted soil at sowing time and when crop residues are ample for erosion control (*2*).[1] Soils that have adequate residues or other protection but are too dry to crop should be fallowed. When there is not enough soil moisture and crop residues for wheat production, sorghum should be substituted. Other cropping systems being used are (1) small grain-small grain-fallow or delayed fallow, (2) sorghum-sorghum-fallow or delayed fallow, and (3) wheat-grain sorghum-fallow or delayed fallow.

During drought that lasts several years, it may not be possible to produce enough cover to keep these soils from blowing. Then the cover should be supplemented by emergency tillage to produce the added cloddiness and roughness to control wind erosion. It may be necessary to construct field diversions or terraces at regular intervals on long, gentle slopes to reduce runoff water to nonerosive velocity. Contour farming on such areas saves much of the needed water for production of crops.

Dryland crops do not respond to commercial fertilizer, because these deep, moderately fine textured soils still retain a large amount of native fertility. Moisture, not fertility, is the factor limiting production on these soils.

[1] Italic numbers in parentheses refer to Literature Cited, p. 66.

Irrigation.—Under irrigation these soils produce high yields of all crops commonly grown in the area. The chief crops grown, sorghum and winter wheat, consistently produce much higher yields if efficient irrigation systems and cropping systems are used. These systems should meet the needs of the soils and the growing crops. Gravity irrigation by level border and level or graded furrows is most commonly used and is suitable for these deep, nearly level, moderately fine textured soils.

Cropping systems should be similar to those used in dryland farming. Fallow or delayed fallow should be omitted, however, and there should be a more regular sequence of crops. Practices, such as contour farming and terracing, are not generally suitable for gravity-irrigated soils.

Methods of tillage and the kind of farm implements used on these irrigated soils also vary. Because of the very slow absorption rate of these soils, tillage must provide temporary storage for additional water in the surface soil. Also, irrigation runs should be longer than for any other cultivated soils. Compacted soils require longer sets or more frequent applications to provide enough water for growing crops. Tilling these soils when too moist should be avoided, for they are easily damaged by compaction.

CAPABILITY UNIT: IIIe-1, DRYLAND FARMING OR IRRIGATION

This unit consists of deep, gently sloping soils that have a clay loam to silty clay loam surface layer. The heavy loam to clay subsoil is slowly to very slowly permeable. It impedes the movement of water and, at times, the development of roots. Moderate water erosion and slight wind erosion are hazards. These soils have a high capacity to hold water and plant nutrients. The soils in this unit are:

Olton clay loam, 1 to 3 percent slopes.
Pullman silty clay loam, 1 to 3 percent slopes.
Richfield clay loam, 1 to 3 percent slopes.

Major management practices are (1) maintenance of cover, roughness, and cloddiness; (2) maintenance of optimum soil structure in surface soil and subsoil; and (3) conserving moisture and reducing runoff to nonerosive velocity.

Although the use of these soils is essentially the same as for soils of capability units IIs-1 and IIIce-1, management requirements are greater. Because of slope, there is a constant danger of water erosion on cultivated areas. Terraces and contour tillage are needed to slow down runoff to nonerosive velocity. This will also permit more water to enter the soil for growing crops. These soils have greater runoff when compacted by excessive tillage or by tillage when the soil is too moist. Deep chiseling overcomes this limitation. It temporarily opens up the soils and allows root penetration. Thus deeply distributed roots, as well as stubble mulching of crop residues, will recondition the damaged soils. Stubble mulching also helps to prevent soil crusting.

The risk of wind erosion is only slight. Soil and crop losses occur, however, if fields are clean tilled or crop residues are heavily grazed. Such damage can be prevented by keeping the soil covered with growing crops or with crop residues. If there is little or no vegetative cover, emergency tillage can be used to produce the added cloddiness and roughness needed to keep the soil from drifting.

Dryland farming.—Winter wheat and grain sorghum are the main crops grown under dryland farming. About the same cropping systems are used as for the similar but less sloping soils of capability unit IIIce-1.

Irrigation.—Under irrigation these soils may produce high yields of all crops commonly grown in the area. Because of the stronger slopes, water erosion is a greater problem on the soils of this unit than on those of capability unit IIs-1. The problem is increased because the soils of this unit take water slowly. Otherwise, soil management, cropping systems, and maintenance of fertility are similar to those described for soils in capability unit IIs-1.

For the same head of water, the graded-furrow runs in the Pullman soil should be longer than for the other soils of this capability unit. Runs, however, need not be as long as for similar less sloping soils.

CAPABILITY UNIT: IIIe-2, DRYLAND FARMING OR IRRIGATION

This unit consists of deep, gently sloping soils. The soils have a clay loam surface layer and a moderately permeable subsoil. They have a moderate capacity to hold water and plant nutrients. The risk of wind erosion is moderate. Because of slope, the soils have a moderate susceptibility to water erosion. The soils in this unit are:

Bippus clay loam, 1 to 3 percent slopes.
Ulysses clay loam, 1 to 3 percent slopes.
Zita clay loam, 1 to 3 percent slopes.

Major management practices on these soils are (1) maintenance of cover, roughness, and cloddiness; and (2) conserving moisture and reducing erosion by runoff control.

About half of the area of these nonextensive, arable soils is used for dryland farming. The rest is in native short grass. Winter wheat and grain sorghum are the main cultivated crops. The native short grass consists chiefly of blue grama and buffalograss.

Young sorghum and corn plants are damaged to some extent on these soils by chlorosis. This is a nutrient deficiency disease caused by excess lime in the soil that presumably ties up the iron and manganese needed by the plant to develop green pigments. After rain or irrigation, the plants may recover and produce a fair yield.

These soils take water at a moderate rate and are easy to till. They generally are more susceptible to wind erosion than water erosion, mainly because of their lime content and the very fine, weak, granular structure of the surface soil. They have a moderate capacity to hold water and plant nutrients. If the Bippus soil is cultivated, it should be protected from runoff from adjacent slopes.

Dryland farming.—The major objective in dryland farming is to use practices that conserve much needed moisture for plant growth and also protect the soils from erosion or deterioration. At the same time, such practices must produce satisfactory yields of tilled crops. Present practices are farming terraced land on the contour and stubble-mulch tillage.

If compacted layers or tillage pans form in these soils, they should be broken by deep chiseling. During the windy season, crop residue or a growing crop must be

maintained to protect these soils. If a crop fails to make a good stand, the surface soil should be roughened by chiseling or listing to trap the drifting soil. Crops should be planted as soon as there is enough moisture.

Irrigation.—Under irrigation high yields of winter wheat, grain sorghum, and other commonly grown crops are reported. Some cotton is also grown. Rye and sudangrass are sometimes grown for pasture and green manure. Since alfalfa and sweetclover require much water, their value as cash crops is doubtful. They help to build up the soils, however, if used for pasture or hay in rotation with other crops in a conservation irrigation system.

These soils respond favorably to the application of barnyard manure and also to commercial fertilizer. The kinds and amounts of fertilizer to be applied should be determined by soil tests and crop needs.

CAPABILITY UNIT: IIIe-3, DRYLAND FARMING OR IRRIGATION

This unit consists of deep, gently sloping to billowy soils that have a fine sandy loam surface layer. These soils have a sandy clay loam subsoil that has moderate to moderately rapid permeability. They have a moderately low capacity to hold water and plant nutrients. The risk of wind erosion is moderate, and that of water erosion is slight. The soils in this unit are:

Dalhart fine sandy loam, 1 to 3 percent slopes.
Spur fine sandy loam (dryland farming only).
Vona fine sandy loam, 1 to 3 percent slopes.

Major management practices are (1) maintenance of cover, roughness, and cloddiness; and (2) conserving moisture.

Most of the acreage of these inextensive soils is still in native grasses, mainly blue grama and bluestem. The rest is mostly used for feed sorghum and for sudangrass pasture. These soils have a lower capacity to hold water and plant nutrients than the deep, moderately fine textured soils with similar slopes. Consequently, they do not have as large yields under optimum moisture conditions.

Dryland farming.—If the soils in this unit are cultivated, there is a moderate risk of wind erosion. Erosion can best be controlled by the use of stubble mulching when sorghum, sudangrass, and other high-residue crops are grown. After grazing or harvesting, about 15 inches of stubble should be left standing to help keep the soil from blowing. If residues are lacking, stubble mulching should be supplemented by roughening the ground, as by listing, to trap the drifting sand before it does any damage. Crops should be planted as soon as there is enough moisture.

Irrigation.—The soils of this unit absorb water readily under irrigation. Therefore, if gravity irrigation is used, much shorter runs are needed than for the fine-textured soils. A sprinkler irrigation system is usually more efficient in applying water on these undulating soils, but loss by evaporation may be high at times. Higher crop yields are obtained when barnyard manure and lighter but more frequent applications of commercial fertilizer are used. The kinds and amounts of fertilizer to use should be based upon soil tests and crop needs.

CAPABILITY UNIT: IVe-1, DRYLAND FARMING

This unit consists of deep, gently to moderately sloping soils. These soils have a clay loam to silty clay loam surface layer. Permeability of the subsoil is very slow to moderately slow. The risk of water erosion is severe, and that of wind erosion is moderate. The damage caused by erosion is evident. The low rainfall, thinner surface soil, and loss of water on excessive slopes limit yields and the kinds of crops that can be grown. The soils in this unit are:

Olton clay loam, 3 to 5 percent slopes.
Pullman silty clay loam, 1 to 3 percent slopes, eroded.
Ulysses clay loam, 1 to 3 percent slopes, eroded.

Major management practices are (1) maintenance of cover, roughness, and cloddiness; and (2) conserving moisture and reducing runoff.

If moisture is adequate, these soils are generally productive. Because of excessive slopes or erosion, they are more safely used for native range than for crops. Most areas of these soils are used for native range, but some areas of the eroded Pullman and Ulysses soils are used for crops. Because of distribution, a large amount of the moderately sloping Olton soil probably will not be farmed for a couple of decades.

Most of the erosion on the Pullman and Ulysses soils is caused by uncontrolled water and wind erosion. Sheet erosion is dominant on those areas affected mostly by water erosion. These areas occur mainly on the Pullman soil. Small gullies that are crossable by tillage implements are also common. Soil loss is mainly by wind erosion on the unprotected, calcareous Ulysses soil. An average of about one-third of the topsoil has been lost through both wind and water erosion.

Dryland farming.—If residues are properly managed on contoured and terraced soils, continuous use for winter wheat and close-grown sorghum will largely control further erosion. Supplemental emergency tillage is necessary if cover is lacking because of drought or other causes. Overtillage and tillage when the soil is too wet should be avoided. These practices destroy the natural soil structure that is so needed to help save moisture for better yields and to resist erosion.

Cropped areas on which the necessary practices are not feasible should be returned to native grasses before it is too late to reestablish them.

Irrigation.—At present it is not practical to irrigate these sloping or eroding soils. The added cost of land preparation and the limited amount of water that can be obtained at a reasonable cost rule out irrigation.

CAPABILITY UNIT: IVe-2, DRYLAND FARMING OR IRRIGATION

This unit consists of deep to shallow, moderately sloping soils. These soils have a loam to fine sandy loam surface layer and sandy clay loam to clay loam subsoil that has moderate to moderately rapid permeability. Because of slope and the sandy surface layer, these soils are subject to moderate water and wind erosion. The loss of water because of slope limits crop yields. The soils in this unit are:

Berthoud fine sandy loam, 3 to 5 percent slopes.
Dalhart fine sandy loam, 3 to 5 percent slopes.
Mansker loam, 1 to 3 percent slopes.

Major management practices are (1) maintenance of cover, roughness, and cloddiness; and (2) conserving moisture and reduction of erosion by runoff control.

The blowing of the clays and silts from the upper few

inches of cultivated areas of the Berthoud and Dalhart soils has made them even more susceptible to wind erosion. For this reason, most areas of these soils that were under cultivation have been returned to native grass.

These medium to moderately coarse textured soils have a higher rate of moisture intake and less capacity to hold water and plant nutrients than the deep, arable, moderately fine textured soils. Because they are single grained or have weak structure, they are more susceptible to wind erosion than any of the arable soils of the county.

Dryland farming.—If these soils are tilled, the crops best suited to them are those that produce much residue and also resist drought. Forage sorghum, sudangrass, rye, and winter wheat are now grown on these soils for supplemental feed and pasture. All of these crops produce much residue. They are needed to supply surface mulch that helps to prevent wind erosion. If crops do not produce adequate cover, emergency tillage should be used. Prompt chiseling or listing will temporarily trap the drifting, cutting sand before much damage occurs.

Irrigation.—If there is enough good water for irrigation, select and lay out an irrigation system that will suit these soils and the cropping system planned for them.

CAPABILITY UNIT: Vw-1

This unit consists of a miscellaneous land type. It occurs on deep bottom lands that are frequently flooded. It includes clay loams to sandy loams that have moderate to moderately rapid permeability. The land type in this unit is:

Alluvial land.

This unit consists of various nonarable soils of the bottom lands. The soils are cut up and frequently flooded by adjacent intermittent streams. Under good native grass, thay have only slight to moderate erosion, chiefly the cutting of stream channels. Channel gullying is becoming a serious problem, however, in a few watersheds where heavy grazing of native range is allowed. Also, improper practices on some of the tilled areas in the watersheds have caused excessive runoff. Thus, the soils have been damaged and channels have been cut downstream.

The chief native grasses on Alluvial land are western wheatgrass, sand bluestem, vine mesquite, side-oats grama, and switchgrass. The section "Range Management" contains information on the use of this land type for production of native grass.

CAPABILITY UNIT: VIe-1

This unit consists of deep to shallow, moderately sloping to sloping, moderately permeable loams. The soils in this unit are:

Berthoud and Mansker loams, 3 to 8 percent slopes.
Dalhart-Mansker loams, 3 to 5 percent slopes.
Mansker loam, 3 to 5 percent slopes.
Mansker loam, 3 to 5 percent slopes, eroded.

Because of shallowness, wind erosion, slope, and the risk of severe water erosion, these medium-textured soils are used for native range.

The native vegetation consists mainly of side-oats grama and blue grama. Some little bluestem and three-awn are on the Mansker soils. The section "Range Management" contains information on use and management of these soils.

CAPABILITY UNIT: VIe-2

This capability unit consists of shallow to deep, moderately sloping to sloping, calcareous fine sandy loams and sandy loams. This unit comprises:

Berthoud and Mansker fine sandy loams, 3 to 8 percent slopes.
Mansker-Potter-Berthoud sandy loams.

Because of shallowness, slope, and the risk of severe wind erosion, the medium-textured soils of these mapping units are unsuited to cultivation. They are used for native range. The native vegetation consists mainly of side-oats grama, blue grama, and little bluestem. There is some yucca.

The section "Range Management" contains information on use and management of these mapping units.

CAPABILITY UNIT: VIw-1

This unit consists of one deep, fine-textured soil in beds of intermittent lakes. The soil in this unit is:

Randall clay.

This soil formed from local wash of clayey sediments from the High Plains. It is often flooded several months, or more, each year by runoff water from the surrounding area. Soil blowing is a hazard where native vegetation is drowned out. Such blowing areas in the bottoms require emergency tillage. Otherwise, material from them will blow onto the more valuable soils on higher lake benches or onto surrounding cultivated soils. If soils that have aquatic vegetation, such as sedges and rushes, are properly grazed, they do not blow during the dry periods between flooding.

This soil is generally not safe for crop production. It is therefore used mostly for native rush and sedge pasture for livestock and wildlife. A number of the smaller, shallower lake bottoms, however, are farmed or grazed during the dry years. The grazed areas are where western wheatgrass and buffalograss become temporarily established during the drier season. These grasses drown out when the rains come again. The section "Range Management" contains information on soil practices.

CAPABILITY UNIT: VIIe-1

This unit consists of deep, hummocky, coarse-textured, rapidly permeable soils. The soils in this unit are:

Likes loamy fine sand, hummocky.
Tivoli fine sand.

These inextensive soils are suitable only for tall and mid grasses and sand sagebrush. They are highly susceptible to wind erosion if disturbed, or if the grasses are heavily grazed.

The Likes soil is usually calcareous throughout and occurs on hummocky relief. The Tivoli soil occurs on a billowy landscape or on distinct sand dunes. Both soils are susceptible to severe wind erosion if disturbed by overgrazing or removal of grasses and sagebrush. These soils make up the best area in the county for recharging the water table.

The section "Range Management" contains information on the use of these soils for native range.

CAPABILITY UNIT: VIIs-1

This unit comprises stony, cobbly, and rough broken lands that occur on the jagged escarpments. Little or no

soil has formed. The soil that has formed is usually in small patches. This unit consists of:

Gravelly rough land.
Rough broken land.
Rough stony land.

The land types in this unit are mostly unsuitable for any use except wildlife habitats and very limited grazing. Exceptions are minor inclusions of silt loam colluvium and alluvium near the base of the Rough stony land. The steep slopes, large boulders, and nearly vertical cliffs of these land types make the few good patches of grass and shrubs difficult to graze.

The native vegetation is usually sparse. It occurs mostly on the steep talus slopes and the included small and sheltered areas that have some soil development. Mid and tall grasses, such as little and tall bluestems, sand bluestem, and side-oats grama, grow on the restricted areas. The section "Range Management" contains information on management of these land types.

CAPABILITY UNIT: VIIs-2

This unit consists of very shallow, strongly to steeply sloping, very calcareous soils. The soils in this unit are:

Potter soils.

These soils are so thin and steeply sloping that they are not suitable for crops. They provide limited forage for grazing livestock, however, and habitats for wildlife.

The native vegetation is mostly sparse stands of grasses, such as side-oats grama, hairy grama, and three-awn. There are some catclaw shrubs. The section "Range Management" contains information on management of these soils.

General Management Practices

Climate is the factor that most affects the agriculture of Carson County. Crops suited to the soils are limited by low, variable annual precipitation and a relatively short growing season. Windstorms, torrential showers, blowing snows, and prolonged, severe droughts are hazards that must be considered in all management—particularly on cultivated soils.

Among the practices needed in soil management are (1) management of crop residues; (2) cropping systems; (3) terracing and contour farming; (4) tillage; (5) moisture conservation; and (6) irrigation.

Management of crop residues.—This is a most important practice. All tillage, planting, cultivating, and harvesting should be done with equipment that will leave crop residues on the surface (*5*). Stubble mulching also will aid in the control of wind and water erosion. It will provide organic matter and decomposition products to stablize aggregates in the surface soil. These aggregates help prevent crusting and improve the rate of water infiltration.

Cropping systems.—The deep, arable, moderately fine textured soils used for crops require a flexible cropping system for efficient crop production and safe use. This system should include mainly winter wheat and sorghum and should be suited to the prevailing climatic conditions. Wheat is the major crop in such a system and should be grown in years when stored soil moisture and crop residues are adequate for erosion control. If soil moisture and crop residues are unfavorable for wheat production, sorghum crops that will resist erosion should be substituted. If wheat crops are blown out or fail from other reasons than lack of moisture, catch crops, such as barley and oats, can be grown. Emergency chiseling or listing may be needed to furnish added cloddiness and roughness to control soil blowing. When climatic conditions are favorable, an alternative cropping system may consist of (1) wheat-summer fallow, (2) wheat-grain sorghum-summer fallow, or (3) wheat-delayed fallow-wheat.

Terracing and contour farming.—On slopes of less than 1 percent, these practices are used mainly for conservation of moisture. On slopes ranging from 1 to 5 percent, they are needed to conserve moisture and control water erosion. Moisture conserved will increase crop production and largely eliminate erosion hazards caused by crop failure and a lack of vegetative cover.

The shallow, sloping, calcareous, medium to moderately fine textured soils require more intense practices, such as continuous growing of small grains and close-drilled feed crops on the contour. Native range, however, would be a better use for these soils.

Tillage.—Excessive tillage or continued tillage without crop residues on the surface causes the exposed soil aggregates to break down to fine particles or single grains. These particles are highly susceptible to blowing. Also, these particles of silt and clay fill the natural pores and channels in which water and air move. Improper tillage impairs tilth, and dense, hard crusts form on the surface.

A plowsole, 1 to 3 inches thick, usually forms in loamy soils when they are continuously tilled at the same depth. The plowsole is dense and hard; it retards the infiltration of moisture and hinders the growth of plant roots. Plowsoles can be largely prevented if, when the seedbed is prepared, the first tillage is deepest and each succeeding tillage is reduced in depth. Deep-rooted crops, however, may do a better job in preventing development of plowsoles.

Stubble-mulch tillage is used to control weeds and to cause the least disturbance to the natural structure and surface residues. Machinery that is commonly used for such tillage consists of sweeps, chisels, rod weeders, and field cultivators. Stubble mulching is one of the best ways to get water to enter the soil for storage in the subsoil. If there is not enough moisture in the subsoil, the feeding zone of growing plants is restricted and crop production is reduced. During prolonged droughts when there is an inadequate cover of vegetation, the soil should be made cloddy or rough by chiseling or listing. Such roughness temporarily breaks the wind impact and traps the drifting soil. Repeated chiseling or listing may be needed to provide roughness until the blowing season is over.

Moisture conservation.—Experimental records indicate that under dryland farming the crops on the moderately fine textured soils of the High Plains do not respond to commercial fertilizer. Moisture, not fertility, is the factor that limits crop production. Moisture conservation must be stressed to get dependable crop production. Two-thirds to three-fourths of the total precipitation is lost through evaporation. Only 60 to 80 percent of the remainder is available for crops under ideal soil and crop management.

The following table shows that stored moisture at planting time is the most important measurable factor that affects the success of a wheat crop (*2*).

TABLE 2.—*Yield of wheat in Southern High Plains in relation to soil moisture at seeding time*

Depth in inches of wetted soil at sowing time	Average yields per acre for stated years when growing season is—	
	Unfavorable (1938 and 1939)	Favorable (1945, 1946, and 1947)
	Bu.	*Bu.*
0 to 12	1.4	9.2
13 to 24	3.1	10.8
25 to 36	8.5	19.7
37 or more	12.6	26.2

Irrigation.—The soils used for crops in Carson County are generally deep and moderately fine textured. Their infiltration rate ranges from 0.05 to 2.5 inches per hour but is mostly less than 0.8 inch per hour. In general they have a high moisture-holding capacity.

The first irrigation well in this county was installed and began supplying water in 1953. Irrigation has steadily increased since that time. As of November 1959, there were 222 irrigation wells (6 and 8 inch) providing excellent water. These wells are mainly used to supplement deficient rainfall on about 54,000 acres of the nearly level, deep, fertile, moderately fine textured soils.

Observation of 30 irrigation wells in the county has indicated that from January 1956 to January 1958 there was an average decline of the underground water level of 3.16 feet per year (fig. 16). Water during that time was removed 20 to 40 (or more) times faster than it was returned by rainfall—the only source of replenishment.

Expenditures for irrigation are greater than for dryland farming. As water levels decline, the yields of wells are reduced and the cost of lifting the water from the greater depth is increased. To meet these added costs, farmers must do a much more efficient job than under dryland farming.

Most farmers test irrigation wells periodically to get information that will help them irrigate more efficiently and economically. Water conservation through the use of underground pipe has also helped make irrigation successful.

An irrigation system should be designed to meet the needs of the soils and to use water resources most efficiently in crop production. The maintenance or improvement of soil structure and soil fertility and the protection of the soil from erosion should be stressed.

Essentially the same cropping system can be used under irrigation as under dryland farming. A better soil improvement program, however, can be carried on under irrigation. More crops can be grown for green manure, and more crop residues can be produced. Also, better use can be made of crop residues because, with ample moisture, it will be practical to add nitrogen fertilizer.

Some farmers overseed wheat or grain sorghum with Hubam clover. This is a good practice if the Hubam clover is used as a green-manure crop. Also, some farmers have increased yields of grain sorghum appreciably by growing cowpeas continuously with the sorghum in the rotation.

The furrow irrigation system is more popular than the border system because the nearly level topography on which it is used requires less preparation and maintenance. Only minor field leveling, smoothing, or planning is required to prepare the flat fields for furrow irrigation. Correct time, rate of water application, and length of run are determined and applied to provide uniform depth of moisture penetration. This depth is within the root feeding zone of the crops grown.

Although a border system of irrigation requires a little more land preparation and maintenance, it is designed for more efficient use of water. The design of a border system is based on soil depth, water intake rate, available water-holding capacity, the amount of irrigation water available, the kind of crops grown, and the kind of farm equipment used. Some bench leveling is done on gently sloping soils. It consists of a series of borders on the contour of the gentle slope, in the manner of stairsteps.

Sprinkler irrigation systems are not usually satisfactory for the moderately fine textured soils. The deep, medium, and moderately coarse textured soils now used as range can be sprinkler irrigated after cultivation, if there is a reliable source of good water.

Commercial fertilizer has proved profitable and advantageous on irrigated soils. Soil tests should be made to determine the kinds and amounts of fertilizer needed. Farmers will thus be assured of maximum crop yields at minimum cost for fertilizer and at a lower water requirement per pound of grain or forage produced. Technicians of the Extension Service will help them to get soil tests.

Farmers are installing more irrigation systems that have underground pipes for carrying water from the wells to the fields. Approximately 75 miles of underground pipe are now used.

Because of the depletion rate of the underground water supply, irrigation may be fairly short lived. More efficient use of the remaining underground water and conserving precipitation by better methods will help make irrigation water last longer.

Technicians of the Soil Conservation District can help select, design, and lay out suitable irrigation systems.

Estimated Crop Yields

Barring climatic hazards, insect pests, and plant diseases, yields of any soil generally reflect the management it has received. Consistently higher yields on a given soil usually indicate that it has been better managed. Under dryland farming the difference in yield of wheat under low-level and high-level management is usually about 1 to 2 bushels per acre. Under irrigation, however, the difference in yield is very marked. There is a much greater opportunity for increasing crop yields by improved practices under irrigation than under dryland farming.

Farmers of Carson County farm under different levels of management because of financial circumstances, size of economic units, kind and condition of equipment, and experience.

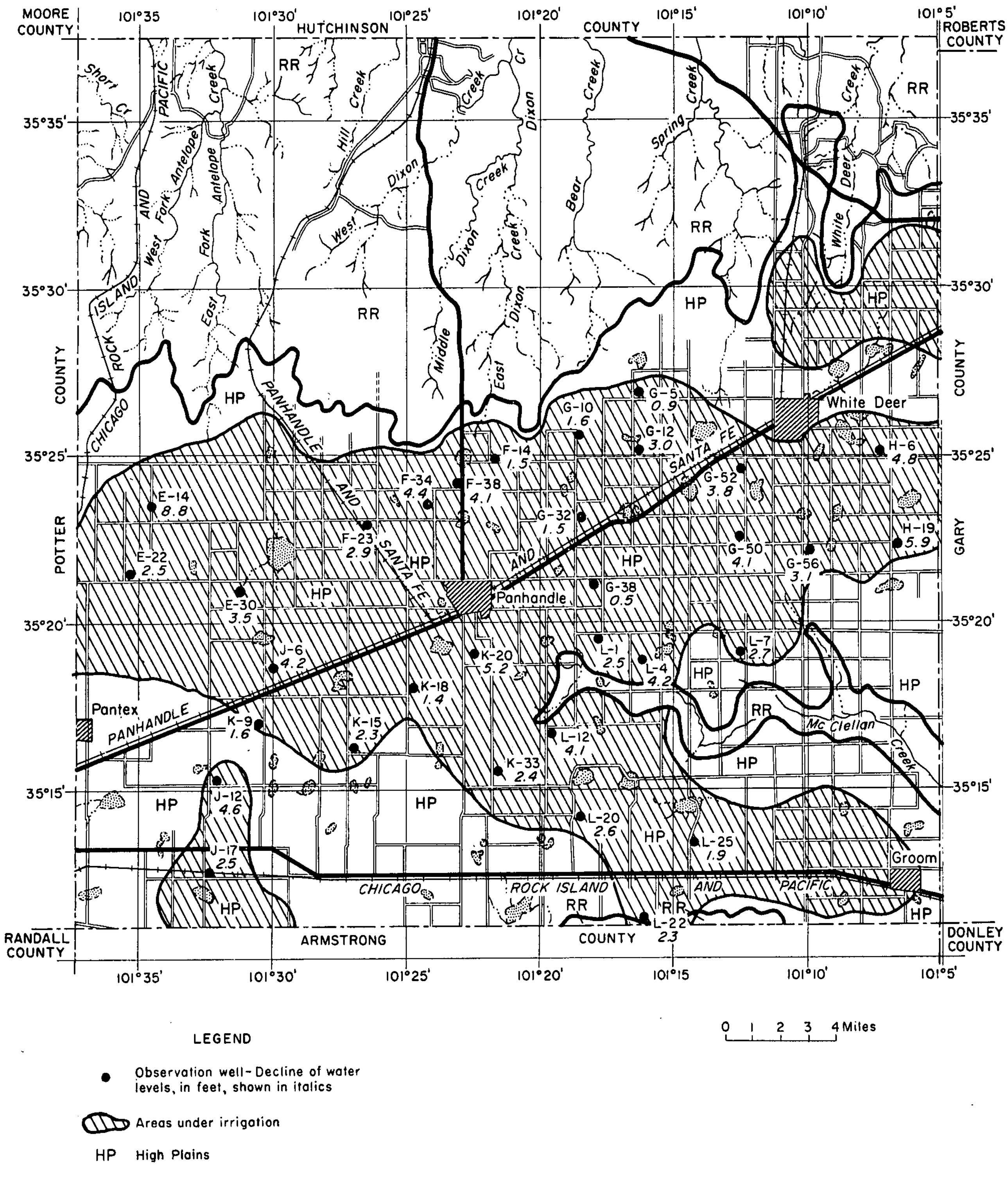

Figure 16.—Extent of irrigation and decline of water levels in Carson County, Tex. (Base map by courtesy of the Texas State Highway Department.)

Table 3 indicates, for each arable soil in the county, the estimated average acre yields for the principal crops under two levels of management. The estimates are based on information furnished by farmers, on observations and comparisons made by those familiar with the soils, and on results of experiments at the Southwestern Great Plains Field Station, at Bushland, and the PanTech Farms, about 6 miles west of Panhandle.

In columns A are yields of wheat, sorghum, and other crops that are likely to be obtained under low-level management for dryland and irrigation farming. In columns B are yields under improved, or high-level, management. Yields for alfalfa are given only for irrigated soils.

The two levels of management are defined in more detail as follows:

A. Low-level management under dryland farming:
1. Little or no effort is made to conserve moisture and save the soil.
2. Crop residues are not managed properly.
3. Emergency tillage is used only for wind erosion control or for occasional plowing of gullies caused by uncontrolled water erosion.
4. The soil is needlessly packed when wet or is pulverized by excessive tillage.

A. Low-level management under irrigation:
1. Little or no effort is made to save and use rainfall.
2. An unsound irrigation system is used that does not meet the needs of growing crops and does not get efficient results from irrigation water.
3. Crop residues are not managed properly.
4. The soils are plowed when wet and are not drained during rare intensely rainy periods.
5. No fertilizer is used or fertilizer is used haphazardly.

B. High-level management under dryland farming:
1. Precipitation is conserved.
2. Diversion, and other terraces, and contour farming are used where needed.
3. Crop residues are conserved and used to help prevent soil loss.
4. Minimum but timely stubble-mulch tillage is used to prevent breakdown of soil structure, to control weeds, and to prepare the seedbed.

B. High-level management under irrigation:
1. Precipitation is conserved.
2. An irrigation system is used that is designed to meet the needs of the growing crops and to utilize irrigation water efficiently.
3. Soil-conditioning or soil-improving crops are grown in the cropping system.
4. The soil is not tilled when wet and is drained during the rare intensely rainy periods.
5. Fertilizer is used in amounts determined by soil analyses and crop needs.

Range Management [2]

Native rangeland is confined chiefly to the northern part of Carson County. This land makes up 49 percent of the acreage of the county. It is generally not suitable for cultivation. Most of the rangeland is rolling (fig.17), but a small part is hilly and broken or stony. The rolling rangeland is alternately deep and shallow. It produces good forage under present management, but forage could be improved by good management.

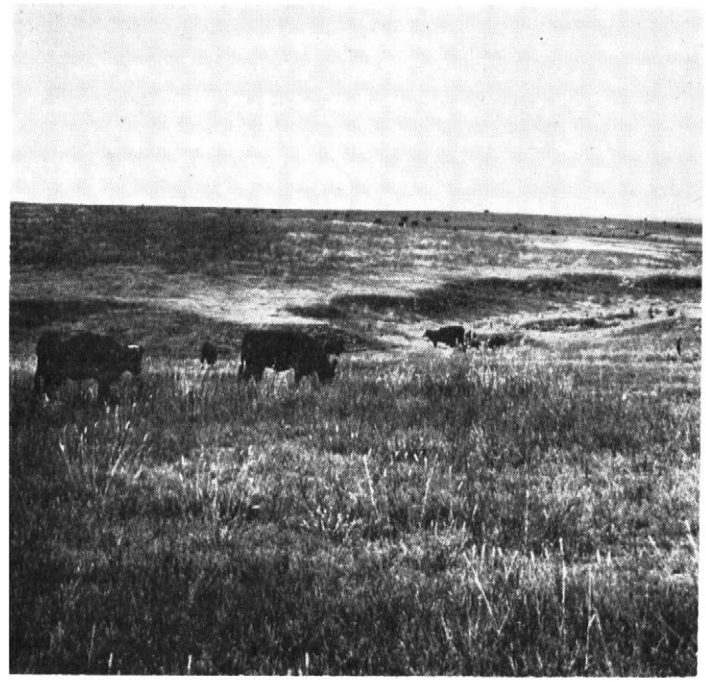

Figure 17.—**Hardland Slopes range site showing rolling topography.**

There are 27 ranches in the county. They are generally large and average over 10,000 acres in size. The rangeland was originally covered with bluestems and grama. It is still in good condition, but there has been some deterioration. Buffalograss and grama have increased on land that was originally in bluestems. There has been some increase of woody plants, such as mesquite and sand sagebrush. Yucca and pricklypear have also increased.

The raising of livestock is the second largest agricultural industry in the county. The success of this industry depends on the way ranchers manage their range forage. A discussion of range management is given in this section.

Management principles and practices

High production of forage and conservation of soil, water, and plants on rangeland are obtained through maintenance of range already in good and excellent condition and by improvement of depleted range. Vegetation is improved by managing the grazing to encourage the growth of the best native forage plants.

Leaf development, root growth, flower stalk formation, seed production, forage regrowth, and food storage in the roots are essential stages in the development and growth of grass. To maintain maximum forage yields and peak animal production, grazing must be regulated to permit these natural processes of growth.

Livestock are selective in grazing and constantly seek the more palatable and nutritious plants. If grazing is not carefully regulated, the better plants are eventually eliminated. Less desirable or second-choice plants will

[2] This section by MARION E. EVERHART, range conservationist, Soil Conservation Service.

TABLE 3.—*Estimated average acre yields of the major tilled crops*

[Yields in columns A are those obtained under a low level of management; those in columns B are to be expected under a high level of used for

Map symbol	Soil	Wheat								Grain sorghum			
		Dryland						Irrigation		Dryland			
		Continuously cropped		Wheat-fallow		Wheat-sorghum-fallow				Continuously cropped		Wheat-sorghum-fallow	
		A	B	A	B	A	B	A	B	A	B	A	B
		Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
BeC	Berthoud fine sandy loam, 3 to 5 percent slopes.	3. 0	4. 0	5. 2	7. 3	5. 0	7. 1	------	------	385	500	480	660
BrB	Bippus clay loam, 1 to 3 percent slopes.	4. 5	6. 6	7. 0	9. 3	8. 5	10. 1	24	40	680	850	810	990
DaB	Dalhart fine sandy loam, 1 to 3 percent slopes.	3. 2	4. 4	5. 1	7. 2	4. 8	6. 7	18	35	725	950	830	1, 020
DaC	Dalhart fine sandy loam, 3 to 5 percent slopes.	2. 8	4. 0	4. 8	7. 6	5. 0	6. 4	------	------	650	750	710	900
Lo	Lofton silty clay loam	7. 0	8. 5	12. 3	15. 2	12. 2	14. 3	33	55	825	975	920	1, 250
Ls	Lofton and Church soils	6. 8	8. 2	11. 2	14. 3	10. 2	14. 1	30	50	620	850	800	1, 060
MkB	Mansker loam, 1 to 3 percent slopes	3. 0	4. 0	5. 0	6. 4	4. 9	6. 0	16	27	380	500	475	590
OcB	Olton clay loam, 1 to 3 percent slopes.	6. 7	7. 8	8. 6	11. 1	8. 0	11. 0	30	52	800	975	880	1, 050
OcC	Olton clay loam, 3 to 5 percent slopes.	5. 7	7. 1	6. 7	10. 3	7. 0	9. 1	------	------	550	780	610	800
PuA	Pullman silty clay loam, 0 to 1 percent slopes.	6. 6	8. 2	11. 2	14. 7	10. 5	13. 2	32	50	830	1, 000	900	1, 200
PuB	Pullman silty clay loam, 1 to 3 percent slopes.	6. 1	6. 8	8. 4	11. 0	7. 6	9. 6	28	45	786	912	842	1, 040
PuB2	Pullman silty clay loam, 1 to 3 percent slopes, eroded.	4. 0	5. 9	6. 8	7. 2	5. 2	7. 6	16	25	660	750	700	840
RcB	Richfield clay loam, 1 to 3 percent slopes.	6. 6	8. 0	9. 0	14. 0	8. 5	13. 0	25	48	750	925	850	1, 100
Sc	Spur clay loam	6. 7	8. 2	11. 5	14. 8	10. 6	13. 4	22	42	850	980	910	1, 250
Sp	Spur fine sandy loam	5. 4	7. 1	8. 4	11. 6	8. 1	11. 0	20	35	550	700	625	820
UcA	Ulysses clay loam, 0 to 1 percent slopes.	5. 5	7. 3	7. 6	10. 5	8. 2	11. 3	27	40	600	840	640	880
UcB	Ulysses clay loam, 1 to 3 percent slopes.	5. 2	6. 7	7. 3	9. 8	7. 0	9. 1	22	35	420	510	460	670
UcB2	Ulysses clay loam, 1 to 3 percent slopes, eroded.	3. 5	5. 5	5. 0	8. 1	5. 5	7. 2	18	29	300	425	380	560
VoB	Vona fine sandy loam, 1 to 3 percent slopes.	3. 5	5. 5	6. 2	9. 3	7. 7	9. 7	20	35	480	610	550	800
ZcA	Zita clay loam, 0 to 1 percent slopes	6. 8	8. 4	11. 4	14. 8	10. 6	13. 3	30	55	820	960	930	1, 150
ZcB	Zita clay loam, 1 to 3 percent slopes	6. 4	7. 2	10. 0	13. 3	9. 8	12. 2	22	45	760	830	800	1, 030

[1] Crop grown when other crops fail.

increase. If heavy grazing is continued, even the second-choice plants will be thinned out or eliminated and undesirable weeds or invaders will take their place (fig. 18).

Research and the experience of ranchers have shown that when only about half the yearly volume of grass is grazed, damage to the desirable plants is minimized and the range is improved. The half of the forage that is left on the ground has the following effect:

1. It serves as a mulch that allows a rapid intake and storage of water. The more water stored in the ground, the better the growth of grass for grazing.
2. It allows roots to reach deep moisture. (Overgrazed grass cannot reach deep moisture because not enough green shoots are left to provide the food needed for good root growth.)
3. It protects the soil from wind and water erosion. Grass is the best kind of cover to prevent erosion.
4. It allows the better grass to crowd out weeds. Thus ranges in a low state of productivity will improve.
5. It enables plants to store food for quick and vigorous growth after droughts and in spring.
6. It holds snow where it falls so that it may melt and soak into the soil for later use. The snow that is blown into drifts melts where it is and is of little benefit.
7. It provides a greater feed reserve for the dry spells that otherwise might force the sale of livestock.

Sound range management requires the control of grazing from season to season according to forage production. Range management should provide for reserve pastures

grown on soils suitable for cropping under two levels of management

management. Absence of yield indicates that crop is not suitable under the management specified. Soils not listed in this table are not cultivated crops]

Grain sorghum—Continued		Forage sorghum						Alfalfa		Catch crops [1]							
Irrigation		Dryland				Irrigation		Irrigation		Barley				Oats			
		Continuously cropped		Wheat-sorghum-fallow						Dryland		Irrigation		Dryland		Irrigation	
A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Lb.	*Lb.*	*Tons* [2]	*Tons* [2]	*Tons* [2]	*Tons* [2]	*Tons* [2]	*Tons* [2]	*Tons*	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
--------	--------	3. 5	4. 4	4. 1	6. 0	------	------	------	------	5	7	------	------	6	8	------	------
2, 600	4, 500	4. 3	6. 0	5. 7	8. 0	11. 0	18. 0	4. 0	6. 0	8	10	25	37	9	11	25	45
2, 500	4, 400	4. 1	5. 2	5. 2	7. 0	9. 0	17. 0	3. 7	5. 5	7	9	22	35	8	10	25	40
--------	--------	4. 0	5. 0	4. 5	6. 5	------	------	------	------	6	8	------	------	7	9	------	------
3, 200	5, 500	5. 5	7. 0	6. 1	12. 0	11. 0	21. 0	5. 1	6. 2	9	12	33	50	15	18	30	60
2, 900	4, 900	4. 8	6. 5	5. 5	10. 0	9. 5	18. 0	4. 7	6. 0	8	11	28	40	9	11	25	40
2, 100	3, 500	3. 5	4. 3	3. 9	5. 0	6. 5	11. 0	3. 5	5. 5	5	7	12	20	6	8	15	25
2, 800	4, 800	4. 6	6. 2	5. 8	8. 2	10. 1	19. 2	4. 0	6. 0	8	12	27	40	11	14	30	45
--------	--------	4. 0	5. 1	4. 8	7. 7	------	------	------	------	7	10	------	------	8	11	------	------
3, 000	5, 000	4. 5	6. 0	4. 5	10. 1	12. 0	20. 0	3. 2	5. 0	10	13	32	42	15	17	25	40
2, 800	4, 600	3. 8	4. 9	4. 3	6. 5	10. 0	16. 0	3. 0	4. 5	8	11	27	35	10	13	20	35
--------	--------	3. 5	4. 1	3. 9	5. 0	------			------	5	8	------	------	7	10	------	------
3, 000	5, 100	4. 6	6. 5	6. 0	8. 5	10. 5	19. 5	4. 2	6. 5	9	12	30	45	13	16	24	42
3, 100	5, 200	4. 3	5. 5	5. 2	7. 5	10. 0	20. 0	4. 0	6. 5	10	13	28	40	14	18	32	45
2, 500	4, 400	4. 0	5. 0	4. 5	6. 5	9. 0	17. 3	3. 5	5. 0	9	12	25	38	9	11	28	40
2, 600	4, 600	4. 0	5. 2	4. 9	7. 5	8. 6	17. 0	4. 0	7. 0	7	9	26	35	8	11	30	42
2, 300	4, 100	3. 9	5. 0	4. 5	7. 0	8. 2	15. 5	3. 8	6. 7	6	8	22	32	8	9	25	35
1, 500	2, 700	3. 2	4. 2	4. 0	5. 6	7. 8	11. 5	3. 0	4. 0	7	8	15	25	7	8	17	30
2, 100	3, 500	3. 9	4. 5	4. 0	5. 0	7. 0	14. 0	3. 0	4. 5	8	11	20	35	9	11	25	35
3, 100	5, 300	4. 3	5. 5	5. 4	7. 2	10. 2	20. 5	4. 0	7. 0	9	12	30	50	12	18	35	50
2, 900	4, 750	4. 1	5. 2	4. 0	6. 0	9. 5	19. 5	3. 0	6. 5	8	11	25	45	10	13	30	45

[2] Wet weight.

or other feed during droughts or other periods of low forage production. Thus the forage can be moderately grazed at all times. In addition, it is often desirable to keep part of the livestock readily salable, such as stocker steers. Such flexibility allows the rancher to balance his livestock production with forage production without the sale of breeding animals.

Grazing practices that improve rangeland, cost little to use, and are needed on all rangeland, regardless of other practices used, are defined as follows:

1. *Proper range use.* This is the rate of grazing that will maintain plant vigor, forage reserves, and adequate residues for soil and water conservation. In addition, the composition of vegetation that has deteriorated is improved by this practice.
2. *Deferred grazing.* This is the postponement of grazing on native rangeland for a definite period. This practice will increase the vigor of the forage or permit the desirable plants to reproduce naturally by seed. In addition, deferred grazing will build up a reserve of forage for later use.

The following are practices that improve range management and help to control livestock:

1. *Range seeding.* This is the establishment of perennial or improved reseeding grasses or legumes to prevent the loss of soil and water and to restore range or land converted from other use.
2. *Water developments.* These should be located over the entire range, if possible, so that livestock do not have to go too far to water. Good distribution of

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watering places helps achieve uniform use of the range. Generally, wells, ponds, developed springs, and pipelines furnish water for livestock, but in some areas water is hauled. The nature of each range will determine which type of water development is the most practical.

3. *Fences.* These should be constructed to provide for good livestock and range management. Ranges may have to be separated according to seasonal use. In some areas, range sites that are large enough and have enough differences should be fenced separately.
4. *Ranch roads.* These can increase the accessibility of all parts of a range and also facilitate the handling of livestock.
5. *Chemical or mechanical control of undesirable plants.* This practice may be needed on some areas to improve forage and also to make easier the handling of livestock.
6. *Salting.* Salting at different places periodically will improve grazing distribution and get more uniform use of the range.

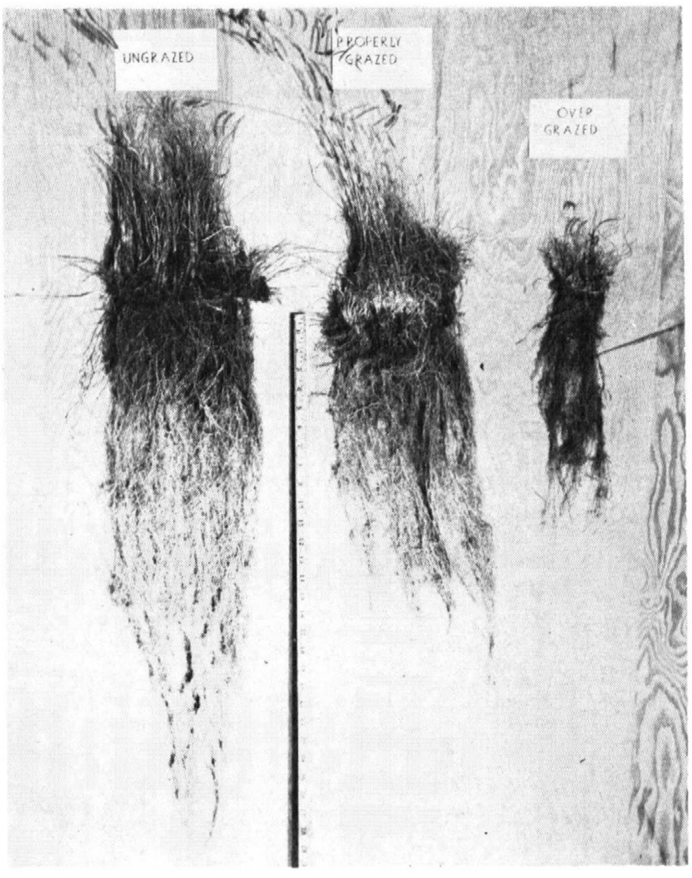

***Figure 18.*—Effects of grazing on root and top growth. These plants were obtained from the same range site and in the same vicinity.**

Livestock management that achieves high production and conserves range resources includes:

1. Grazing animals suited to the forage, soils, and climate of the range. Generally, cattle do best on ranges that are mostly grass. Sheep do best where forage contains a large amount of broad-leaved plants and browse. Under some conditions a combination of different kinds of animals may be desirable.
2. A feed and forage program that provides for available range forage, concentrates, and hay or tame pastures, or both, to keep livestock in good condition throughout the year.
3. A breeding program that provides for the type of livestock best suited to the range, a supply of calves or lambs in seasons when forage is most nutritious, and continued animal improvement consistent with the type of range and climate.

Range sites and condition classes

Different kinds of ranges produce different kinds and amounts of grass. For proper range management, an operator should know the different kinds of soil or range sites in his holdings and the plants each site can grow. Management can then be used that will favor the growth of the best forage plants on each kind of soil.

Range sites are areas of rangeland that differ from each other in their ability to produce a significantly different kind or amount of climax, or original, vegetation. A significant difference is one that is large enough to require different grazing use or management to maintain or improve the present vegetation. Climax vegetation is the combination of plants that originally grew on a given site. The most productive combination of range plants on a site is generally the climax type of vegetation. Range condition is classified by comparing the present vegetation with the climax vegetation on the site. Range condition is expressed as follows:

Condition class	*Percentage of climax vegetation on the site*
Excellent	76–100
Good	51–75
Fair	26–50
Poor	0–25

Ranges in excellent or good condition yield more and have the most cover for conservation of soil and water. Knowledge of range sites and range condition classes helps ranchers determine the value and needs of the range.

Range technicians use descriptions of range sites to record factual information about the vegetation of a range site. The Hardland range site (fig. 19) is described in detail as follows:

Climate.—Precipitation on this range site averages about 22 inches. Annual rainfall occurs mostly from May through October. In each month there are 2 inches or more. Extreme fluctuations, including periodic droughts, occur from year to year. Torrential showers that produce high runoff on unprotected soils commonly occur in summer. Winter precipitation (snow or rain) averages less than an inch per month.

Wind velocities are extremely high in this area in comparison with the rest of the United States. High winds during March and April cause much erosion on unprotected areas.

The growing season of the native warm-season plants begins on April 17, which is the average date of the last killing frost in spring. If moisture is available, the growing season lasts until October 31—the average date ending

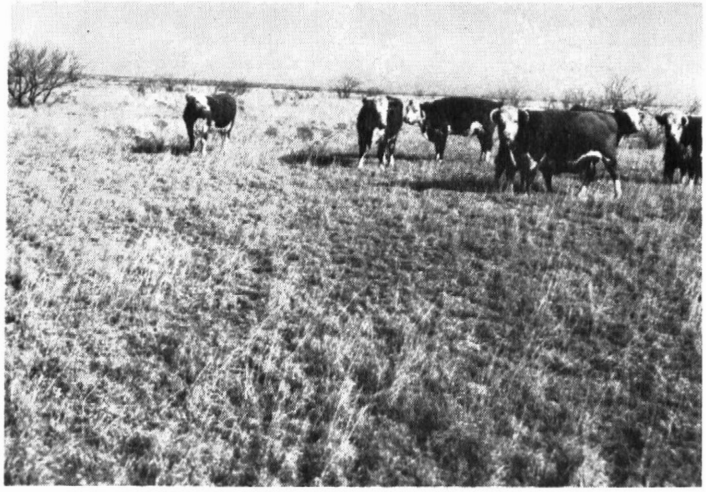

Figure 19.—**A Hardland range site that is properly used.**

the frost-free period. Winters are characterized by frequent "northers" (wind) that produce severe cold. The recorded low is $-16°$ F.; the maximum summer temperature recorded is 108°. Summer humidity is low and evaporation is high.

Topography and elevation.—The Hardland range site occurs on flat to sloping areas. It is on all elevations common to the area.

Soils.—The soils characteristic of this site have clay, silty clay loam, clay loam, loam, and sandy clay loam surface layer textures. They are 20 inches or more in depth to parent materials. Permeability ranges from very slow to moderate. If unprotected by vegetation, these soils are susceptible to slight wind and water erosion from intense storms. Significant soils in this site include Lofton silty clay loam, Lofton and Church soils, and Pullman silty clay loam.

Vegetation.—Decreasers make up about 70 percent of the vegetation (5 percent mid grasses and 65 percent short grasses). Increasers and invaders make up the rest. Decreasers and increasers are climax plants. Decreasers are the most heavily grazed and are consequently the first to be destroyed by overgrazing. Increasers withstand grazing better or are less palatable to the livestock; they increase under grazing and replace the decreasers. Increasers finally decrease, also, if grazing pressure continues. Invaders are weeds that become established after the climax vegetation has been reduced by grazing.

Decreasers on this range site are blue grama; vine-mesquite (confined to low areas); western wheatgrass (confined to low areas); and side-oats grama (confined to the medium-textured soils). Increasers are buffalograss and silver bluestem. Invaders are three-awn, sand dropseed, western ragweed, brown snakeweed, mesquite, small soapweed, sand muhly, and annuals.

Site productivity.—The Hardland range site in excellent condition will produce 750 to 1,200 pounds (air-dry weight) of usable forage under good management. This measurement is based on plot clipping.

Basal areas of clumps or bunches cover 25 to 35 percent of the ground. A variation of 25 percent of this amount is allowed because of differences in soil and climate.

RANGE SITES IN THE COUNTY

The range sites in Carson County are Hardland, Mixed Land, Hardland Slopes, Mixed Land Slopes (fig. 20), Bottom Land, Sandy Land, Shallow Land (fig. 21), and Rough Breaks (fig. 22). The soils of the county by range sites, the plants originally dominant on each site, and range site productivity are given in table 4.

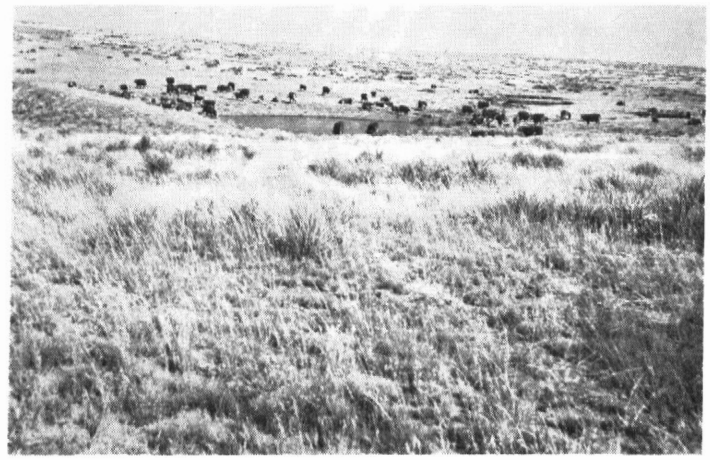

Figure 20.—**Area of Mixed Land Slopes range site.**

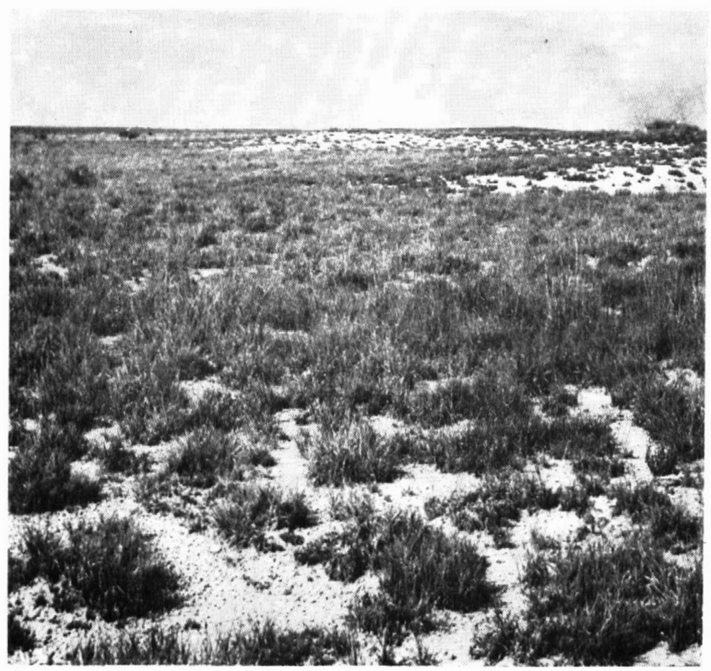

Figure 21.—**Bluestem grasses on Shallow Land range site in excellent condition.**

TABLE 4.—*Range site, plants originally dominant on each site, and range site productivity*

Range site and soil	Dominant plants when site is in excellent condition	Site productivity of usable air-dry forage [1] when the site is in excellent condition
		Lbs. per acre
Hardland	Blue grama, western wheatgrass, buffalograss, and side-oats grama.	750–1, 200
Bippus clay loam, 1 to 3 percent slopes.		
Lofton silty clay loam.		
Lofton and Church soils.		
Mansker loam, 1 to 3 percent slopes.		
Olton clay loam, 1 to 3 percent slopes.		
Olton clay loam, 3 to 5 percent slopes.		
Pullman silty clay loam, 0 to 1 percent slopes.		
Pullman silty clay loam, 1 to 3 percent slopes.		
Pullman silty clay loam, 1 to 3 percent slopes, eroded.		
Randall clay.		
Richfield clay loam, 1 to 3 percent slopes.		
Spur clay loam.		
Ulysses clay loam, 0 to 1 percent slopes.		
Ulysses clay loam, 1 to 3 percent slopes.		
Ulysses clay loam, 1 to 3 percent slopes, eroded.		
Zita clay loam, 0 to 1 percent slopes.		
Zita clay loam, 1 to 3 percent slopes.		
Mixed Land	Side-oats grama, blue grama, sand dropseed, and buffalograss.	1, 000–1, 400
Dalhart fine sandy loam, 1 to 3 percent slopes.		
Dalhart fine sandy loam, 3 to 5 percent slopes.		
Vona fine sandy loam, 1 to 3 percent slopes.		
Hardland Slopes	Side-oats grama and blue grama.	1, 000–1, 400
Berthoud and Mansker loams, 3 to 8 percent slopes.		
Hardland Slopes—Continued		
Dalhart-Mansker loams, 3 to 5 percent slopes.		
Mansker loam, 3 to 5 percent slopes.		
Mansker loam, 3 to 5 percent slopes, eroded.		
Mixed Land Slopes	Little bluestem, side-oats grama, and blue grama.	1, 200–1, 600
Berthoud fine sandy loam, 3 to 5 percent slopes.		
Berthoud and Mansker fine sandy loams, 3 to 8 percent slopes.		
Mansker-Potter-Berthoud sandy loams.		
Spur fine sandy loam.		
Bottom Land	Western wheatgrass, sand bluestem, vine-mesquite, side-oats grama, switchgrass, and Indiangrass.	2, 000–3, 100
Alluvial land.		
Sandy Land	Sand bluestem, little bluestem, and side-oats grama.	1, 500–2, 000
Likes loamy fine sand, hummocky.		
Tivoli fine sand.		
Shallow Land	Little bluestem, side-oats grama, and sand bluestem.	700–900
Potter soils.		
Rough Breaks	Little bluestem and side-oats grama.	200–500
Gravelly rough land.		
Rough broken land.		
Rough stony land.		

[1] Pounds of forage produced under proper range management.

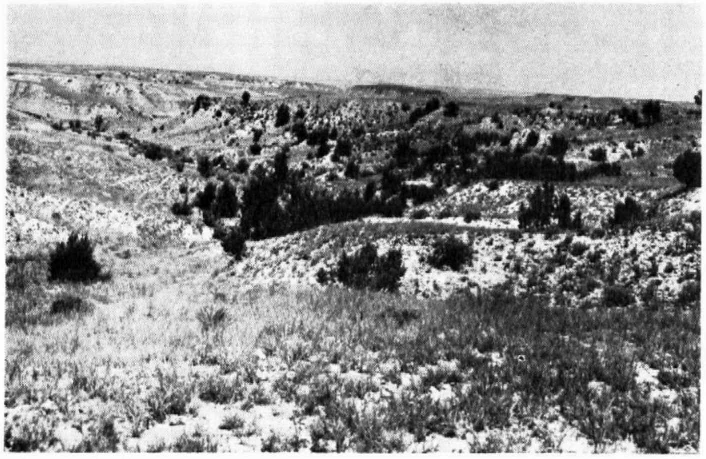

Figure 22.—**Rough Breaks range site. This site provides cover for wildlife and grazing for livestock.**

Farmstead and Feedlot Windbreaks [3]

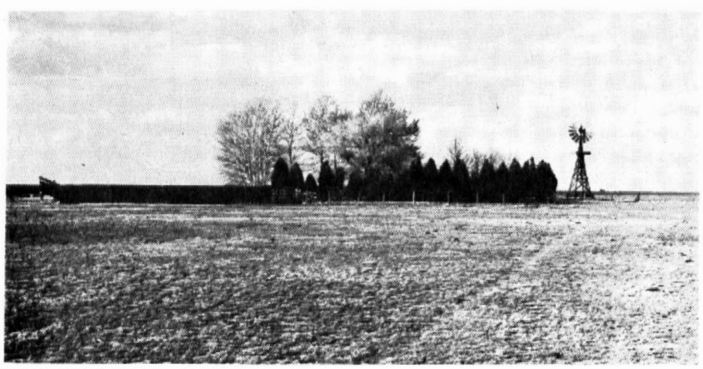

Figure 23.—**A feedlot windbreak planted near a windmill and loading pens.**

Research has shown the value of windbreaks. The Lakes State Forest Experiment Station conducted experiments in Nebraska and Kansas. Exact fuel requirements were recorded in identical testhouses. One house was protected from north winds only. The other was exposed to the full sweep of the wind. A constant house temperature of 70°F. was maintained in both houses. The experiment showed that the amount of fuel used in the house protected from north winds was 20.2 percent less than that used in the unprotected house.

Research at the Montana Agricultural Experiment Station showed the value of a feedlot windbreak. It was found that cattle wintered outdoors during a mild winter in natural brush and tree shelters gained 34.9 pounds more per head than those kept in a shed lot. Both groups were fed identical rations. In Nebraska and South Dakota, 86 cattle feeders figured that a windbreak saved each of them $800 annually.

A well-located windbreak protects buildings and livestock from the north and west winds. Such evergreens as redcedar and such shrubs as tamarisk or Russian-olive should be grown in the windbreaks with Chinese elms or other deciduous trees.

Wildlife [4]

There are many kinds of wildlife in the county. Ducks, killdeer, geese, and herons live in playas and livestock ponds and along the shores. Birds of the upland include blackbirds, meadowlarks, and such game birds as the eastern bobwhite quail and mourning dove. Wild animals in the county are antelopes, skunks, jackrabbits, ground squirrels, coyotes, prairie dogs, and badgers. Antelopes prefer the open prairie and, like coyotes, are in all range areas of the county. Deer are occasionally seen in Carson County but live mostly in the rough land of adjoining counties to the north and south.

Bobwhite quail have increased since the ranchers started leaving grass on their ranges to conserve the maximum amount of soil and water. Many odd areas have been fenced to exclude livestock; thus, food and cover for wildlife have been developed. Some plants suitable for wildlife food or cover have been planted. Antelopes are protected from hunters by the landowners and graze on the range along with the cattle.

Sunfish, crappie, bass, and catfish live in the stocked ponds. Fish for stocking are obtained yearly by landowners who construct or rework ponds. These ponds provide fishing for the local residents but are not sufficient for the fishermen of the area. Springs along Dixon Creek and elsewhere contain a few fish.

Skunks and other insect-eating animals, as well as rodent eaters, such as hawks, owls, coyotes, and badgers, make their living from the land and water areas. All kinds of wildlife can exist on the ranches, however, if food, cover, and water are provided.

The development or protection of natural wildlife habitats are important in wildlife management. Such areas should be protected from grazing and burning. Brushy areas and some rough, broken areas should be fenced. Many ponds could be improved by fencing the dams and spillways and by stocking them with the correct kinds and amounts of fish. Fertilizer should then be applied to the pond water. Shrubs, such as Russian-olive, can be planted for cover and food for wildlife. Areas used for wildlife furnish economic returns from hunting and fishing rights. Feedlot windbreaks provide excellent areas for wildlife.

Geology

The origin of the High Plains is significant in the geologic history of the area. During Permian time (roughly 200 million years ago), a large area that included nearly all of the Panhandle of Texas, eastern New Mexico, and the Panhandle and the western part of Oklahoma was under a shallow sea. Sediments deposited in this sea formed what is known as the Permian red beds. When

[3] See footnote 2, p. 29.

[4] See footnote 2, p. 29.

the High Plains rose above the level of the sea, streams flowed over the exposed Permian rocks and eroded fine-textured materials and deposited them along the flood plains. These materials formed the Triassic red beds.

During Cretaceous time, a part of the High Plains was again covered by a shallow arm of the sea. Sand, silty clay, and limestone were deposited on the sea bottom.

As the Rocky Mountains were forming, swift streams from these mountains cut valleys and canyons through the Cretaceous and Triassic rocks and into the Permian rocks. Nearly all of the Cretaceous deposits and in places all of the underlying Triassic deposits on the High Plains were washed away toward or into the gulf.

The Rocky Mountains began to erode when they approached their maximum height. Coarse, gravelly Cenozoic materials were carried long distances by swift streams. As the mountains eroded, the streams became less swift and they deposited gravel, sand, and silt nearer their sources to form the Ogallala deposits. These deposits finally formed a massive fan of coarse, gravelly outwash material near the foot slopes of the mountains. The finer materials were spread out eastward for several hundred miles over coarser outwash material of earlier but similar origin. In places these Ogallala deposits were up to 700 feet in thickness and reached nearly to the present level of the High Plains (*4*, *6*).

The water-bearing sands of the Ogallala formation make up the largest and most valuable natural water reservoir in this part of the nation. So far as is known, the underground water is replenished only by precipitation on the High Plains and on the exposed Ogallala materials bordering the High Plains on the north. The average recharge rate is estimated at less than 1 inch annually. The water table slopes very gently to the southeast, and the water flow is estimated to be as much as 1 to 2 feet per day.

All evidence indicates that there is no underground flow of water from the Rocky Mountains. This source has been cut off for many thousand years by the Canadian River to the north and the Pecos River to the west. Since the Triassic and Permian formations that underlie the Ogallala formation are nearly impervious to water, it is questionable that good water can be obtained economically from lower formations.

The amount of water available for irrigation varies according to the thickness of the water-bearing Ogallala sands and the depth to the red-bed formations. Figure 16 shows where irrigation is most extensive in the county. Generally no irrigation water can be obtained economically elsewhere.

Just before the ice age, the High Plains section of the Great Plains physiographic province was a relatively smooth plateau. The glaciers of Recent time did not reach as far south as Carson County. They produced, however, a cool, humid climate in the area. Because of the heavy precipitation, a few large rivers and valleys were formed. The rivers include the Canadian, Cimarron, and Arkansas to the north, the Pecos to the west, and the Red to the south. All of these rivers have cut through the Cenozoic and, where present, the Triassic deposits. In places they have cut deeply into the Permian deposits.

Eolian and loessal deposits finally capped the High Plains. These deposits are called cover sands by Frye and Leonard (*3*) and others. They range from a few feet to well over 100 feet in thickness. The most extensive upland eolian materials of Pleistocene time were deposited during the early Wisconsin glacial stage. Peorian loess reached a maximum thickness of more than 100 feet from northern Texas to northern Nebraska. These eolian and loessal deposits are considered to be the parent materials of most of the soils of Carson County.

Formation, Classification, and Morphology of the Soils

Factors of Soil Formation

Soil is a function of climate, living organisms, parent materials, relief, and time. The nature of the soil at any point on the earth depends upon the combination of the five major factors at that point. All five of these factors come into play in the genesis of every soil. The relative importance of each differs from place to place; sometimes one is more important and sometimes another. In extreme cases one factor may dominate in the formation of the soil and fix most of its properties, as is common when the parent material consists of pure quartz sand. Little can happen to quartz sand, and the soils derived from it usually have faint horizons. Even in quartz sand, however, distinct profiles can be formed under certain types of vegetation where the topography is low and flat and a high water table is present. Thus, for every soil the past combination of the five major factors is of the first importance to its present character.

The interrelationships among the factors of soil formation are complex, and the effects of any one factor cannot be isolated and identified with certainty. It is convenient, however, to discuss the factors of soil formation separately and to indicate some of their probable effects. The reader should always remember that the factors interact continually in the processes of soil formation and that the interactions are important to the nature of every soil.

Climate.—Precipitation, temperature, humidity, and wind have been important in the development of the soils of Carson County. The wet climate of past geologic ages influenced the deposition of parent materials. Later, as a result of limited rainfall that seldom wet the soil below the area of living roots, most of the zonal and intrazonal soils developed a horizon of calcium carbonate accumulation. This lack of rainfall has caused many of the younger soils to have free lime throughout the profile.

Wind is an outstanding factor in the development of soils in this area. It has affected soil development from the time it deposited sands over the pre-existing land surface during Pleistocene time to its present shifting of coarse sands on the surface.

Living organisms.—Vegetation, micro-organisms, earthworms, and other forms of life that live on and in the soil contribute to its development. The type and amount of vegetation are important. They are determined partly by the climate and partly by the kind of parent materials. Climate limited the vegetation of Carson County to grasses. The parent materials determined whether the grasses would be tall, as on the sands, or short, as on the clays.

The mixed prairie type of native vegetation contributed large amounts of organic matter to the soil. Decaying grass, leaves, and stems distributed this organic matter on the soil surface. Decomposition of the fine roots dis-

tributed it throughout the solum. The network of tubes and pores left by these decaying roots hastened the passage of air and water through the soil and provided abundant food for bacteria, actinomycetes, and fungi.

Earthworms are the most noticeable form of animal life in the soils of Carson County. Despite the low rainfall in this area and periods when the entire solum is dry, the importance of earthworms in soil development is easily seen. A large proportion of the B_2 horizons of some of the zonal soils consists of wormcasts. Wormcasts add greatly to the movement of air, water, and plant roots in the soil.

Soil-dwelling rodents have had a part in the developmant of some soil areas. Farmers who occupied the land since it was in native grass know where large prairie-dog towns thrived. The burrowing of these animals did much to offset the leaching of free lime from the soil. It destroyed soil structure that was already formed. A good example of such soils occurs within large areas of Chestnut soils. In contrast to the undisturbed Chestnut soils around them, soil affected by prairie-dog burrowing are calcareous to the surface, have weaker structure in the subsoil, and have weaker C_{ca} horizons in many places.

The influence of men on the soil-forming factors should not be ignored. At first men fenced the range, overgrazed it, and changed the vegetation. They then plowed the land to plant crops. By harvesting crops and allowing runoff and wind erosion, they reduced the amount of organic matter and the silt and clay particles in the plow layer. Through the use of heavy machinery and poorly timed tillage, men produced compacted areas that reduced infiltration of water and aeration. They have drastically changed the moisture regimes in some areas by irrigating. Thus, things that have occurred in the past 50 years have shown marked effects on the soils of the county.

The way that men treat the soil in future generations will affect its further development.

Parent materials.—The nature of the parent materials, particularly their texture and lime content, greatly influences soil development. Soils that have developed from fine-textured materials generally have developed more rapidly and to a greater degree than soils that have developed from coarse-textured materials. The parent materials of the soils of Carson County are largely alkaline to calcareous, unconsolidated sandy and silty earths. These materials were derived principally from Rocky Mountain outwash, which, in part, has been reworked by wind action. The geology of these materials is discussed in more detail in the section "Geology."

Relief.—Relief influences soil development through its effect on drainage and runoff. The degree of profile development depends mainly on the average amount of moisture in the soil, if other factors of soil formation are equal. The soils on steep slopes absorb less moisture and normally have less well-developed profiles than soils on flats and in depressions. Besides, the soil-forming processes on steep slopes are retarded by continuous erosion.

Relief also affects the kind and amount of vegation on a soil; however, this is not so important in Carson County. Slopes facing north receive less direct sunlight than those facing south, so they lose less moisture through evaporation. As a result, soils on slopes facing north have a somewhat denser vegetative cover and are generally more strongly developed. Also, the prevailing westerly winds have deposited soil materials on slopes facing east and have removed soil materials from those facing west. As a result, in many areas the soils are deeper and better developed on slopes facing east.

Some examples of the influence of topography and drainage upon the development and distribution of soils in the county (illustrated in figures 24 and 25) are discussed in this section under the heading "Soil Toposequences."

Time.—The characteristics of a soil are strongly affected by the length of time that the soil-forming factors have acted upon the soil. Soil parent materials that have been in place for only a short time have not yet been influenced enough by climate and living organisms to develop well-defined and genetically related soil horizons. Examples of such very young depositional soils in Carson County are the Spur soils, recently deposited on bottom lands, and the eolian dune areas associated with the Likes and Tivoli series.

On steeper slopes soils have immature profiles because geologic erosion has removed the products of soil formation. The steeper areas of Potter and Mansker soils are examples of such immature, hilly soils. Soils that have been in place for a long time have approached equilibrium with their environment in soil development, and they have mature, well-developed profiles. These soils show marked horizon differentiation. They are generally well-drained soils that occupy the gently sloping areas of the county, as represented by the Pullman and Dalhart series.

Soil Toposequences

Topography influences the development and distribution of soils and gives rise to recurring sequences or patterns of geographically associated soils. These soils differ from one another primarily because of the effect of differences in topographic position. Soils which characteristically occur in such a sequence or pattern constitute, collectively, a *toposequence.* In Carson County this relationship is shown by the two major toposequences illustrated in figures 24 and 25. Figure 24 shows a toposequence of soils in areas of intermittent small lake basins or playas, figure 25 shows the relation of soils to landform in the area of High Plains escarpments.

Playas of the High Plains, illustrated in figure 24, are largest and most numerous in areas of fine-textured parent materials. The area covered by the soils in the playa shown in figure 24 and the depth of the playa basin are representative of the larger playas of Carson County; the playas vary tremendously in size and depth, however, and may cover thousands of acres. Very small playas less than a foot deep are locally called wet spots. Young, small playas are generally circular, and each is a separate drainage basin. As the margins expand, however, separate playas overlap or merge in many places. In this way basins of dumbbell shape and, occasionally, strings or clusters of coalescing playas are formed.

Soil development on the saucerlike playas has been markedly influenced by runoff and accumulation of water, erosion, and deposition of silts and clays, and movement of lime and soluble salts. The characteristics of soils in the toposequence shown in figure 24 vary according to topographic position. For example, those of the soils on the outer rim of the playa vary widely from those of the soil on the bottom of the basins.

On the steeper slopes near the basin rim, loss of water by runoff restricts soil moisture, and as a result the vegetative

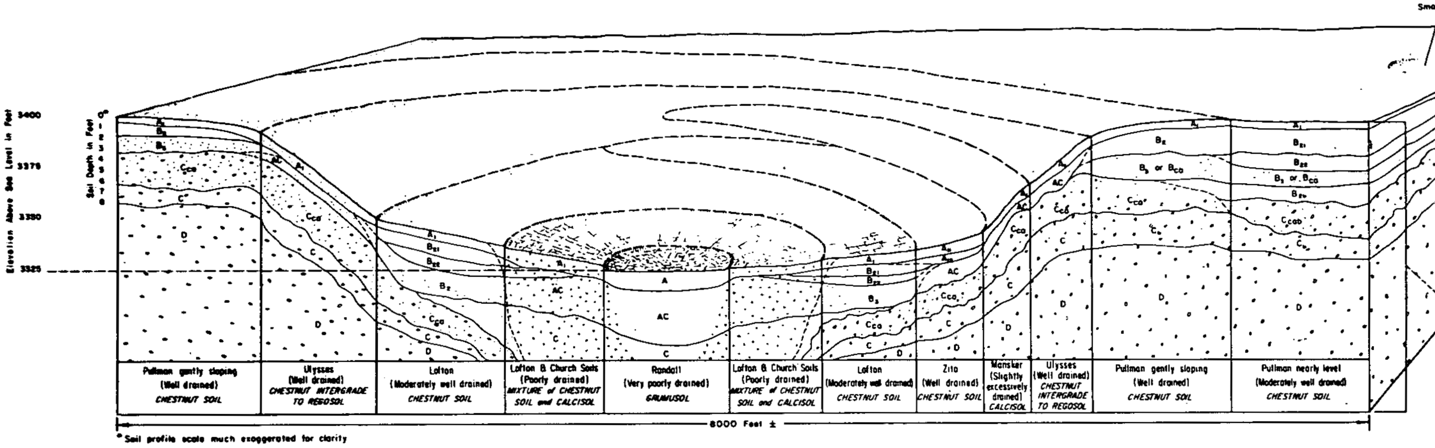

Figure 24.—**Soil toposequence of playas.**

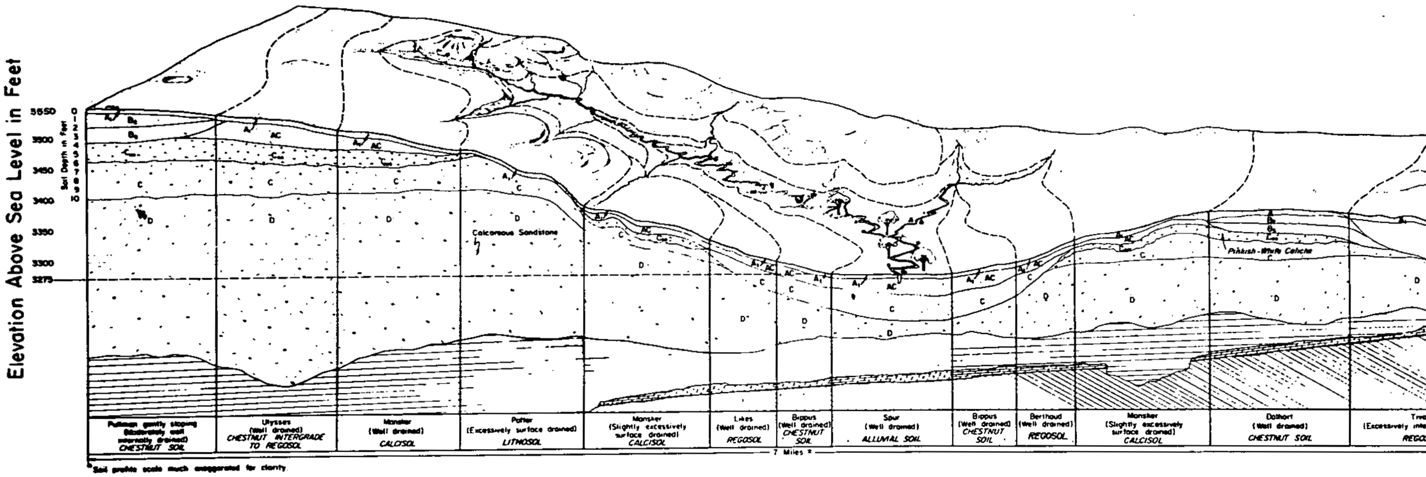

Figure 25.—**Soil toposequence of the escarpment separating the High Plains from the Rolling Plains**

cover is sparse. These sloping, relatively exposed soils are thus more subject to periodic removal of surface soil materials by runoff or wind action. Under such conditions, the soils are young in terms of soil development. They still contain large amounts of calcium carbonate, and they have only weakly developed genetic soil profiles. As shown is figure 24, these young, shallow soils in Carson County are classified with the Mansker series, which are intrazonal soils of the Calcisol group. On the more gentle slopes adjacent to areas of Mansker soils, the well-drained Ulysses soils occur as another member of the toposequence. Ulysses soils have profiles representative of the Chestnut soil group, but because genetic horizons are weakly developed, the Ulysses soils are classified as Chestnut soils intergrading toward the Regosol group.

On the intermediate positions between the basin rim and the low-lying playa center, the soils receive additional moisture from surrounding higher areas. Thus they have more organic matter and thicker vegetation than Mansker soils. These soils are subject also to occasional surface deposition of moderately fine textured soil materials that have been eroded from adjacent soils on higher ground. As shown in the toposequence diagram in figure 24, soils of the Lofton series occupy these intermediate topographic positions. Lofton soils are moderately well drained zonal soils of the Chestnut soil group. Genetic profiles are well expressed, but evidence of periodic deposition on the surface of Lofton soils is inferred from the frequent occurrence of buried, older horizons within the soil profiles. An example of such buried horizons is shown in the description of the profile of Lofton silty clay loam given in the section "Descriptions of the Soils."

At the center and lowest part of the playa, the soils receive water from all of the surrounding slopes; during wet seasons, they may be under standing water for considerable periods. The high supply of soil moisture produces abundant organic matter, which imparts dark colors and thick A horizons to these soils. Besides receiving water by surface and subsurface flow, these soils of the playa bottoms are subject to surface deposition of soil materials washed from all other soils in the toposequence. Deposition of such materials takes place, for the most part, in standing water; for this reason the sediments consist only of the finer-textured materials of clay and silt size. Figure 24 shows that the Randall soils commonly occupy the playa bottoms in Carson County. Randall soils are very poorly drained and dark colored. They have very deep profiles, with clay or silty clay textures, and they are generally leached of carbonates in the upper 4 or 5 feet.

The combination of fine clay materials and periodic wetting and drying causes recurrent shrinkage and swelling in the soil mass. Upon drying, the Randall soils develop wide shrinkage cracks and some of the dry, friable surface soil sloughs and washes into these cracks. When the soils become wet again, the cracks close as the soil mass swells. The added volume caused by the surface materials that entered the subsoil through the cracks when the soil was dry causes pressure to build up when the soil becomes wet. Evidence of great pressure within the fully saturated soil mass is inferred from the prevalence of shiny pressure faces, called slickensides, in profiles of Randall soils. The expansion of the soils upon wetting causes extensive movement within the soil along the planes of the slickensides. Over a cycle of many such sequences of alternate wetting and drying, the Randall soils undergo slow but thorough churning. One result of this continued churning in the Randall soils is a remarkable uniformity and lack of horizon differentiation in the upper few feet of the dark-colored, clayey profiles. The Randall series is a good representative of intrazonal soils of the Grumusol group.

In the area astride the broad escarpment that delineates the regional boundary between the High Plains and the Rolling Plains of Western Texas, soils and topography are related by another toposequence of soil series. The distribution of these soils in relation to topography in Carson County is illustrated in figure 25.

The toposequence of the escarpment area, as shown in figure 25, is more complex than the toposequence of soils of the playas (figure 24). The complexity of soil development and distribution at the escarpment arises from the additional influences on soil formation exerted by (1) stream dissection and the deposition of alluvial and colluvial sediments; (2) removal and deposition of sandy parent materials by wind action; and (3) variations in parent materials of the soils of the toposequence.

Surface runoff and subsurface water movement, removal and deposition of erosion products, and solution and movement of carbonates have much the same effect on the development of soil profiles in areas of the escarpment toposequence as in areas in the playas. The more complex topographic and geologic conditions in the escarpment area, however, have given rise to wider variations in soil profiles and a larger number of soil series.

On topographic positions where materials are relatively stable, the soils have developed well-expressed genetic profiles. Examples of these well-developed zonal soils are the Dalhart and the Pullman soils of the Chestnut soil group.

At the other extreme, are the very young azonal soils without appreciable development of genetic horizons. As shown in figure 25, these young soils are represented by the Spur series and the Tivoli series. The Spur soils of the Alluvial soil group are forming in recently deposited sediments of stream bottoms. Tivoli soils of the Regosol group are also forming in recently deposited sediments, but their parent materials are windblown sands.

Classification of Soils by Higher Categories

Classification consists of an orderly grouping of defined kinds of soils into classes in a system designed to make it easier to remember soils, including their characteristics and interrelationships, and to organize and apply the results of experience and research to areas ranging in size from plots of several acres to large bodies of millions of square miles. The defined kinds of soils are placed into narrow classes for use in detailed soil surveys and in the application of knowledge within farms and fields. The many thousands of narrow classes are then grouped into progressively fewer and broader classes in successively higher categories so that information can be applied to large geographic areas.

Classes of soils defined on a comparable basis and of the same rank in a classification system comprise what is called a category. A comprehensive system of soil classification, one which will be useful in dealing with the soils of a small field as well as with the soils of a continent, plus land areas of intermediate size, must therefore consist of a number of categories. The higher

categories consist of fewer and broader classes than the lower categories.

The system of soil classification now being used in the United States consists of six categories, one above the other. Each successively higher category consists of a smaller total number of classes, and each of those classes has a broader range of characteristics. Thus, there are thousands of classes in the lowest category and no more than three in the highest category. The intermediate categories are also intermediate in number of classes and in permissible span, or breadth, of each class. Beginning at the top, the six categories in the system of soil classification are the order, suborder, great soil group, family, series, and type.

Four of the six categories have been widely used, and two have been used very little. Of the two higher categories, the order and great soil group have been widely used. The two lowest categories, the soil series and soil type, have also been widely used. On the other hand, the categories of the suborder and family have never been fully developed and are therefore of little value now. In soil classification and mapping, attention has been largely given to the recognition of soil types and series within counties or comparable areas and to the subsequent grouping of the series into great soil groups and orders. The two lowest categories have been used primarily for study of soils of small geographic areas, whereas the categories of the order and great soil group have been used for the study of soils of large geographic areas.

Differences in the breadth, or span, of individual classes in each category are indicated by the total number of classes in that category. All soils in the United States are included in three classes in the highest category, that of soil orders. These same soils are placed in some three dozen great soil groups, comprising a category of somewhat lower rank. Going down the ladder to the next lower category in general use, approximately 6,000 soil series have been recognized in the United States. More series will be recognized as the study of soils continues, especially in areas where little work has been done in the past. The total number of soil types is not known exactly, inasmuch as records are not maintained for individual soil types as is done for individual soil series. The total number of soil types recognized in the country as a whole, however, would be at least twice as large as the number of series. From comparison of the respective numbers of orders, great soil groups, series, and types, it is immediately obvious that the ranges permitted in the properties of soils within one class in a category of high rank are broad, whereas ranges within individual classes in a category of low rank are relatively narrow.

The nature of each of the four categories of the order, great soil group, series, and type will not be described at length in this section. The soil series and the soil type are defined in the Glossary. The categories of the soil order and the great soil group are described briefly in the subsequent paragraphs.

The highest category in the present system of soil classification consists of three classes, known as the zonal, intrazonal, and azonal orders. The zonal order comprises soils with evident, genetically related horizons that reflect the dominant influence of climate and living organisms in their formation. The intrazonal order comprises soils with evident, genetically related horizons that reflect the dominant influence of one or more local factors of parent materials, topography, and time over the effects of climate and living organisms. The azonal order comprises soils that lack distinct, genetically related horizons because of one or more of the following—youth of parent materials, resistance of parent materials to change, and steep topography. In the text of this report, these orders are often referred to as zonal soils, intrazonal soils, and azonal soils.

Because of the way in which the soil orders are defined, all three can usually be found within a single county, as is true in Carson County. Two of the orders and sometimes all three of them may occur in a single field.

Classification of a soil series into one of the three orders does indicate something about the factors of major importance in the formation of that soil. The classification into orders also indicates something about the degree of expression of horizons in soils, or, in other words, the degree of horizonation. Even so, the ranges in properties are wide among the soils in any one order when all of them are considered collectively. Consequently, the total number of statements that can be made for any one order and which will be valid for all soils within that order are limited. Primarily, the orders indicate something about important factors of soil formation and something about degree of horizonation.

The great soil group is the next lower category beneath the order that has been widely used in this country. Classes in that category have been used to a very great extent because they indicate a number of relationships in the soil genesis and also indicate something of the fertility status, adaptability for crops or trees, and the like.

Each great soil group consists of a large number of soil series with many internal features in common. Thus, all members of a single great soil group in either the zonal or intrazonal order have the same number and kind of definitive horizons in their profiles. These definitive horizons need not be expressed to the same degree, nor do they need to be of the same thickness in all soils within one great soil group. Specific horizons must be recognizable however, in every soil profile of a soil series representing a given great soil group.

Great soil groups in the azonal order are defined in part on the nature of the profile and also in part on history or origin of the soil. All members of a single great soil group have a number of internal features in common, but none of the three great soil groups in the azonal order has distinct horizonation. Consequently, all of them still bear a strong imprint of the materials from which they are being formed. Definitions of the great soil groups in the azonal order are centered on a part of the profile approximately comparable in thickness to the solum of associated great soil groups of the zonal and intrazonal orders.

Most soil series have characteristics that are representative of one or another of the great soil groups, and they are classified accordingly. A few soil series, however, have some characteristics of two great soil groups; such soil series are grouped with the great soil group they resemble most closely but are classified as intergrading to the other great soil group. For example,soil series that are within the Chestnut soil group but have weakly expressed horizons are classified as Chestnut soils intergrading to Regosols.

The classification of soil series in Carson County into great soil groups and soil orders is given below. Each series recognized in the county has been classified on the basis of the current understanding of the soils and their formation.

ZONAL ORDER
- *Chestnut soils:*
  - Bippus (intergrading to Regosols)
  - Dalhart
  - Lofton
  - Pullman
  - Richfield
  - Ulysses (intergrading to Regosols)
  - Zita (intergrading to Regosols)
- *Reddish Chestnut soils:*
  - Olton
- *Brown soils:*
  - Vona

INTRAZONAL ORDER
- *Calcisols:*
  - Church*
  - Mansker
- *Grumusols:*
  - Randall

AZONAL ORDER
- *Alluvial soils:*
  - Spur
- *Lithosols:*
  - Potter
- *Regosols:*
  - Berthoud (intergrading to Brown soils)
  - Likes
  - Tivoli

*Provisional classification, subject to possible revision upon further study of the Church series.

Soil Morphology

The relationship of the outstanding morphological characteristics of the soils of Carson County to the factors of soil formation is briefly discussed in this section.

In Carson County the zonal order includes three great soil groups: Chestnut soils, Reddish Chestnut soils, and Brown soils.

There are seven series in the Chestnut soil group, which is the most extensive in the county. The Chestnut soils are dark brown or dark grayish brown and grade into whitish, calcareous horizons at a depth of 1½ to 4 feet. They have distinct, genetically related horizons and other soil characteristics that show the predominant influence of climate and living organisms in their formation. These soils have distinct A, B, C horizon sequences. The series in Carson County in this group are the Bippus, Dalhart, Lofton, Pullman, Richfield, Ulysses, and Zita series. The Bippus, Ulysses and Zita series are classified with the Chestnut soil group but, because of the weakness of their profile development, they are recognized as intergrading toward the Regosol group.

Only the Olton series is included in the Reddish Chestnut soil group in Carson County. The soils of this series are reddish brown and normally grade into white or pink caliche at depths of 40 to 60 inches.

In this county only the Vona series is classified in the Brown soil group. The soils of this series have brown, noncalcareous surface soils that grade to yellowish-brown subsoils over light-colored, calcareous, unconsolidated substrata at depths of 3 to 4 feet.

The intrazonal soils in Carson County comprise the Calcisol and Grumusol great soil groups. The soils of Church and Mansker series are Calcisols. The soils of the Randall series are Grumusols.

Church and Mansker soils are considered Calcisols because of the thick accumulation of calcium carbonate in their profiles. As mapped in Carson County, the Church soils include some profiles that are not fully representative of the Calcisol group. Church soils have developed from highly calcareous, clayey parent material. Until very recent geologic times, this material made up lakebeds. The lack of development in Mansker soils may be caused by relief, age, or parent material.

The soils of the Randall series, the only Grumusols in Carson County, have developed in the playa beds from clayey materials. Because of their low-lying position, they have developed under wet conditions.

The azonal order in this county contains three great soil groups. These are the Alluvial soils, Lithosols, and Regosols. The azonal soils usually show only a weak A_1 horizon.

Soils of the Spur series are Alluvial soils. They are dark brown and very immature. They occur in draws and along small stream bottoms.

The Potter soils are Lithosols. These soils lack development because of geologic erosion on the steep slopes.

The Berthoud, Likes, and Tivoli series are Regosols. Soils of this group lack appreciable development of genetic horizons except for some weak expression of an A_1 horizon at the surface. Tivoli soils are young soils that have developed in windblown parent materials containing very little clay or minerals subject to weathering.

The outstanding genetic and morphological relationships of the major soils of Carson County are shown in table 5. All the soils of Carson County are neutral or alkaline. Most of them have a base saturation of 80 to 100 percent.

TABLE 5.—*Genetic and morphological*

Soil type	Great soil group	Horizons	Soil profile color (dry)	Texture	Structure
Berthoud fine sandy loam.	Regosols (intergrading to Brown soils).	A_1	Grayish brown (10YR 5/2).	Fine sandy loam.	Compound weak coarse prismatic and granular.
		AC	Brown (7.5YR 5/3)	Light sandy clay loam.	Compound weak coarse prismatic and granular.
Bippus clay loam	Chestnut soils (intergrading to Regosols).	A_1	Dark grayish brown (10YR 4/2).	Clay loam to sandy clay loam.	Compound moderate medium granular to weak coarse prismatic.
		AC	Dark brown (7.5YR 4/2).	Clay loam	Compound moderate coarse prismatic and fine granular.
Dalhart fine sandy loam.	Chestnut soils	A_1	Dark brown (7.5YR 4/2).	Fine sandy loam.	Compound weak coarse prismatic and moderate fine granular.
		B_2	Dark brown (7.5YR 4/2).	Sandy clay loam.	Compound moderate coarse prismatic and moderate medium blocky.
		B_3	Brown (7.5YR 5/2)	Sandy clay loam.	Weak coarse prismatic and granular
Likes loamy fine sand	Regosols	A_1	Brown (10YR 5/3)	Loamy fine sand.	Compound weak fine granular and single grained.
		AC	Pale brown (10YR 6/3).	Loamy fine sand.	Very weak very coarse prismatic and granular.
Lofton silty clay loam	Chestnut soils	A_{1p}	Very dark grayish brown (10YR 3/2).	Silty clay loam.	Structureless to weak, fine and very fine granular.
		B_{21}	Very dark to dark grayish brown (10YR 3/2).	Clay	Compact moderate to strong medium blocky.
		B_{22}	Dark grayish brown (10YR 4/2).	Silty clay	Moderately strong medium blocky
		B_{2b}	Reddish brown (5YR 5/4).	Clay loam	Moderate coarse subangular blocky and blocky.
Mansker loam	Calcisols	A_1	Grayish brown (10YR 5/2).	Loam to sandy clay loam.	Weak very coarse prismatic breaking to moderate fine and medium granular.
		AC	Light grayish brown (10YR 6/2).	Clay loam	Weak very coarse prismatic breaking to moderate medium granular.
Olton clay loam	Reddish Chestnut soils.	A_1	Dark brown (7.5YR 4/2).	Clay loam to sandy clay loam.	Weak medium prismatic breaking to moderate fine granular.
		B_2	Reddish brown (5YR 4/4).	Light clay	Moderate fine and medium blocky
		B_3	Yellowish red (5YR 5/8).	Sandy clay loam.	Weak medium to coarse blocky
Potter soils	Lithosols	A_1	Grayish brown (10YR 5/2).	Loam to fine sandy loam.	Weak fine and very fine granular with with some hard and soft caliche.
Pullman silty clay loam.	Chestnut soils	A_{1p}	Dark grayish brown (10YR 4/2).	Silty clay loam.	Weak fine subangular blocky and granular.
		B_{21}	Dark brown (10YR 4/3 to 7.5YR 4/2).	Clay	Moderately strong medium blocky
		B_{22}	Brown (7.5YR 4/2)	Clay	Strong medium blocky
		B_{ca} or B_{23}.	Brown (7.5YR 4/2)	Clay	Moderate medium blocky
		B_{2b}	Reddish brown (5YR 5/3).	Silty clay	Moderate medium blocky
Randall clay	Grumusols	A_1	Dark gray (N 4/0)	Clay	Weak fine and medium blocky to massive.
		AC	Dark grayish brown (2.5Y 4/1).	Clay	Massive

characteristics of the major soils of Carson County

Consistence	Reaction	Thickness	Substratum	Topography
		Inches		
Very friable when moist, slightly hard when dry.	Strongly calcareous	8–14	Unconsolidated, moderately fine textured, calcareous colluvial and alluvial upland sediments.	Moderately sloping upland foot slopes.
Very friable when moist, hard when dry.	Very strongly calcareous	10–26		
Friable when moist, hard when dry.	Noncalcareous	6–8	Unconsolidated, fine-textured, calcareous local alluvium.	Gently sloping upland foot slopes.
Less friable when moist, hard when dry.	Weakly to strongly calcareous.	10–23		
Very friable when moist, slightly hard when dry.	Noncalcareous	7–13	Unconsolidated, moderately fine textured, calcareous eolian upland deposits containing some fine caliche.	Nearly level to moderately sloping, erosional uplands.
Friable when moist, hard when dry.	Noncalcareous	9–16		
Slightly sticky when wet, friable when moist.	Strongly calcareous	11–24		
Soft when dry	Weakly calcareous to noncalcareous.	9–15	Unconsolidated, medium to coarse-textured, very calcareous colluvial and eolian upland deposits.	Hummocky and sloping uplands.
Soft when dry	Weakly to strongly calcareous.	12–38		
Slightly sticky when wet, friable when moist.	Noncalcareous	6–10	Unconsolidated, fine-textured, very strongly calcareous, earthen material.	Level to nearly level first benches above playa bottoms.
Sticky when wet, extremely hard when dry.	Noncalcareous	10–24		
Sticky when wet, very hard when dry.	Weakly to strongly calcareous.	30–45		
Friable when moist, hard when dry.	Strongly calcareous	8–20+		
Very friable when moist	Strongly calcareous	7–9	Unconsolidated, fine-textured, very strongly calcareous material.	Gently sloping to sloping uplands.
Friable when moist	Strongly calcareous	7–10		
Very friable when moist, slightly hard when dry.	Noncalcareous	6–9	Unconsolidated, fine-textured, strongly to very strongly calcareous material.	Gently sloping to moderately sloping erosional plains of the uplands.
Firm when moist, very hard when dry.	Noncalcareous	18–24		
Friable when moist, hard when dry.	Slightly to strongly calcareous.	22–30		
Very friable when moist, slightly hard when dry.	Strongly calcareous	6–9	Semi-indurated, gravelly and platy caliche.	Sloping to steeply sloping erosional uplands.
Friable when moist, hard when dry.	Noncalcareous	5–8	Unconsolidated, fine-textured, slightly mottled, calcareous earthen material.	Nearly level to gently sloping plains of the uplands.
Sticky when wet, very hard when dry.	Noncalcareous	8–18		
Very sticky when wet, extremely hard when dry.	Slightly calcareous	11–29		
Firm when moist, very hard when dry.	Strongly calcareous	10–25		
Firm when moist, very hard when dry.	Weakly calcareous	15–35+		
Very sticky and plastic when wet, very hard when dry.	Noncalcareous	20–40	Dark-gray, sticky, calcareous local alluvial sediments.	Level bottoms of depressions or playas.
Very sticky and plastic when wet, extremely hard when dry.	Noncalcareous to calcareous.	18–30		

TABLE 5.—*Genetic and morphological characteristics*

Soil type	Great soil group	Horizons	Soil profile color (dry)	Texture	Structure
Richfield clay loam	Chestnut soils	A_1	Very dark grayish brown (10YR 3/2).	Clay loam	Weak to moderate medium granular
		B_1	Dark grayish brown (10YR 4/2).	Light clay	Moderate medium and fine subangular blocky.
		B_{21}	Dark grayish brown (10YR 4/2).	Clay	Moderate medium blocky
		B_{22}	Grayish brown (10YR 5/2).	Clay	Moderately strong medium blocky
		B_{23}	Grayish brown (10YR 5/2).	Light clay	Moderate to weak medium blocky to subangular blocky.
Spur clay loam	Alluvial soils	A_1	Dark grayish brown (10YR 4/2).	Clay loam	Moderate medium prismatic and granular.
		AC	Dark brown (7.5YR 4/2).	Clay loam	Moderate medium prismatic and granular.
Tivoli fine sand	Regosols	A	Pale brown (10YR 6/3).	Fine sand	Structureless
Ulysses clay loam	Chestnut soils (intergrading to Regosols).	A_1	Grayish brown (10YR 5/2).	Light clay loam.	Weak fine granular
		AC	Brown (7.5YR 5/2)	Clay loam	Moderate coarse prismatic and moderate fine granular.
Vona fine sandy loam	Brown soils	A_1	Grayish brown (10YR 5/2).	Fine sandy loam.	Weak fine granular
		B_1	Brown (10YR 5/3)	Fine sandy loam.	Weak very coarse prismatic and medium granular.
		B_2	Yellowish brown (10YR 5/4).	Light fine sandy clay loam.	Compound moderate very coarse prismatic and granular.
Zita clay loam	Chestnut soils (intergrading to Regosols).	A_{1p}	Dark grayish brown (10YR 4/2).	Clay loam and loam.	Structureless
		A_{12}	Very dark grayish brown (10YR 3/2).	Silty clay loam.	Moderately strong fine subangular blocky and granular.
		AC	Grayish brown (10YR 5/2).	Light silty clay loam.	Moderate fine subangular blocky and granular.

Engineering Applications[5]

This soil survey report for Carson County, Tex., contains information that can be used by engineers to—

(1) Make soil and land use studies that will aid in the selection and development of industrial, business, residential, and recreational sites.
(2) Assist in designing drainage and irrigation structures and planning dams and other structures for water and soil conservation.
(3) Make reconnaissance surveys of soil and ground conditions that will aid in selecting highway and airport locations and in planning detailed soil surveys for the intended locations.
(4) Locate sand and gravel for use in structures.
(5) Correlate pavement performance with types of soil and thus develop information that will be useful in designing and maintaining the pavements.
(6) Determine the suitability of soil units for cross-country movements of vehicles and construction equipment.
(7) Supplement information obtained from other published maps and reports and aerial photographs for the purpose of making soil maps and reports that can be readily used by engineers.

The mapping and the descriptive report are somewhat generalized, however, and should be used only in planning more detailed field surveys to determine the in-place condition of the soil at the site of the proposed engineering construction.

Some of the terms used by the agricultural soil scientist may be unfamiliar to the engineer, and some words—for example, soil, clay, silt, sand, aggregates, and granular—may have special meanings in soil science. These and other special terms that are used in the soil survey report are defined in the Glossary in the back part of the report.

[5] This section by JAMES H. MILLER, agricultural engineer, Soil Conservation Service. Assistance and advice was furnished by engineers of the Texas State Highway Department.

of the major soils of Carson County—Continued

Consistence	Reaction	Thickness	Substratum	Topography
		Inches		
Very friable when moist, slightly hard when dry.	Noncalcareous	5– 8	Unconsolidated, fine-textured, strongly calcareous earthen material.	Gently sloping erosional uplands.
Friable when moist, hard when dry.	Noncalcareous	9–14		
Firm when moist, very hard when dry.	Noncalcareous	10–15		
Sticky when wet, very hard when dry.	Weakly calcareous	9–12		
Hard when dry	Strongly calcareous	10–12		
Friable when moist, hard when dry.	Slightly calcareous	8–18	Unconsolidated, fine-textured, calcareous alluvial material.	Nearly level bottom land.
Friable when moist, hard when dry.	Strongly calcareous	9–25		
Loose when dry	Noncalcareous	4– 8	Loose, fine, noncalcareous eolian sand.	Stabilized sand dunes.
Very friable when moist	Calcareous	7–10	Unconsolidated, fine-textured, very strongly calcareous earthen material.	Nearly level to moderately sloping plains of the uplands.
Friable when moist	Strongly calcareous	14–28		
Loose when dry	Noncalcareous	8–18	Unconsolidated, noncalcareous or weakly calcareous eolian material and reworked, strongly calcareous outwash material.	Gently sloping to moderately sloping erosional uplands.
Very friable when moist	Noncalcareous	10–20		
Very friable when moist, hard when dry.	Weakly to strongly calcareous.	12–22		
Very friable when moist	Noncalcareous	7–10	Unconsolidated, fine-textured, strongly calcareous chalky material.	Nearly level to gently sloping plains of the uplands.
Very friable when moist, slightly hard when dry.	Noncalcareous	8–12		
Friable when moist, hard when dry.	Weakly to strongly calcareous.	9–22		

Engineering Classification Systems

Most highway engineers classify soil materials according to the system approved by the American Association of State Highway Officials (*1*). In this system soil materials are classified in seven principal groups. The groups range from A–1, in which are gravelly soils of high bearing capacity, to A–7, which consists of clay soils having a low strength when wet. In each group the relative engineering value of the soil material is indicated by a group index number. Group indexes range from 0 for the best material to 20 for the poorest. The group index number is shown in parentheses following the soil group symbol in the next to the last column in table 8.

Some engineers prefer to use the Unified soil classification system (*7*). In this system soil material is divided into 15 classes: 8 classes are for coarse-grained material (GW, GP, GM, GC, SW, SP, SM, SC), 6 for fine grained (ML, CL, OL, MH, CH, OH), and 1 for highly organic material (Pt.). Mechanical analyses are used to determine the GW, GP, SW, and SP classes of material; mechanical analyses, liquid limit, and plasticity index are used to determine GM, GC, SM, SC, and fine-grained soils. The soils of the county have been classified only in the SP, SM, SC, ML, CL, CH, MH, GW, SW classes of material (see tables 6 and 8).

Engineering Interpretations

Engineering interpretations are given in three tables. In table 6 the soils are briefly described, and the physical properties significant to engineering are estimated. In table 7 the suitability of the soils for various engineering practices is estimated. In table 8 test data are given for some of the soils. Tests to obtain the data in table 8 were made by the Texas State Highway Department and were reviewed by the Bureau of Public Roads.

In table 6 the depths of the various horizons or layers are the same as those in the section "Descriptions of the Soils." The data in the other columns are estimated. Definitions for permeability, available water, dispersion, shrink-swell potential, and other engineering terms are given in the Glossary.

The information in table 7 was derived after considering the estimated physical properties shown in table 6, the test data in table 8, and field experience with the soils.

TABLE 6.—*Brief description of soils in Carson*

Map symbol	Soil	Site and soil description	Typical profile		Classification	
			Depth	Horizon	USDA texture	AASHO
			Inches			
Au	Alluvial land	Narrow bands of sandy loam to clay loam deposited by streams in channels and along their edges; usually deep, but very deep in places; usually subject to channel erosion and flooding; horizons, if any, very poorly defined; noncalcareous to strongly calcareous depending on the parent material; layers of sand and gravel throughout the profile in some areas.			Sandy loam to clay loam.	A–4 to A–7–5.
BeC	Berthoud fine sandy loam, 3 to 5 percent slopes.	Colluvial and alluvial sediments; usually on the steeper slopes below Potter or Mansker escarpment materials and above Bippus soils on the more gentle slopes; generally calcareous to the surface; well drained; mostly rangeland.	0–8 8–30 30–42 42–65+	A_1 AC C C_b	Fine sandy loam Sandy clay loam Fine sandy loam Clay	A–4 A–6 A–4 A–6
BfD BmD	Berthoud and Mansker fine sandy loams, 3 to 8 percent slopes. Berthoud and Mansker loams, 3 to 8 percent slopes.	Occur chiefly in the transitional area between the High Plains and the Rolling Plains in the northern part of the county; usually adjacent to and north of Berthoud and Mansker loams. Mansker soils are shallow and occupy the tops of low ridges; Berthoud soils are deeper and occupy the swales and draws between the Mansker ridges. (Berthoud and Mansker loams, 3 to 8 percent slopes, usually occur below Mansker and Potter soils and above Berthoud and Mansker fine sandy loams.)				A–2 to A–4
BrB	Bippus clay loam, 1 to 3 percent slopes.	Formed from alluvial deposits washed from the edge of the High Plains above; generally between Berthoud clay loam on the slope above and Spur soil on the slope below; up to 50 inches of fine-grained soil; usually noncalcareous at the surface to strongly calcareous at the C_{ca} horizon.	0–14 14–27 27–50+	A_1 AC C_{ca}	Clay loam to sandy clay loam. Clay loam Clay loam to silty clay loam.	A–4 or A–6 A–4 or A–6 A–4 or A–6
DaB DaC	Dalhart fine sandy loam, 1 to 3 percent slopes. Dalhart fine sandy loam, 3 to 5 percent slopes.	Formed from plains outwash and eolian deposits; occur mostly on erosional upland plains in the northwestern part of the county; deep, mature, well drained, medium textured, noncalcareous at the surface to strongly calcareous at the C_{ca} horizon. (Dalhart fine sandy loam, 3 to 5 percent slopes, is very similar to Dalhart fine sandy loam, 1 to 3 percent slopes, but steeper and redder.)	0–9 9–22 22–34 34–54 54–57+	A_1 B_2 B_3 C_{ca} D	Fine sandy loam Sandy clay loam Sandy clay loam Sandy clay loam Caliche	A–4 A–4 or A–6 A–4 or A–6 A–4 or A–6
DmC	Dalhart-Mansker loams, 3 to 5 percent slopes.	Usually in the smoother, upper part of the transitional area between the High Plains and the Rolling Plains. The smoother, more level areas are Dalhart loams that grade into the steeper, thinner areas of Mansker loams.	For Dalhart soils, see data for Dalhart fine sandy loam, 1 to 3 percent slopes; for Mansker soils, see data for Mansker loam, 1 to 3 percent slopes.			

See footnotes at end of table.

County, Tex., and their estimated physical properties

Classification—Continued	Percentage passing sieve [1]—			Permeability [2 3]	Available water [2 3]	Reaction (pH value) [3]	Dispersion [2 3]	Shrink-swell potential [2 3]
Unified	No. 4 (4.76 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)					
				Inches per hour	*Inches per foot of depth*			
SM–CL	70–100	60–100	40–80	0.5–1.5	1.2–2.0	6.0–8.0	Low to moderate.	Low to moderate.
SM or SC SC SM or SC SC or CL	85–100	75–100	40–90	0.5–1.0	1.5–1.8	6.5–8.0	Low	Low.
SM or SC to CL	95–100	75–100	45–90	0.5–1.0	0.8–1.8	6.5–8.0	Low	Low.
SM–SC or CL	97–100	95–100	40–70	0.5–0.9	1.2–2.4	6.5–8.0	Low	Low.
SC or CL	97–100	95–100	45–75					
SM–SC or CL	97–100	95–100	35–75					
SM, ML, or CL	90–100	85–95	40–60	0.5–1.0	1.2–1.8	6.0–8.0	Low	Low.
CL	90–100	85–95	65–80					
CL	85–100	75–90	55–70					
CL	85–100	75–90	55–70					
For Dalhart soils, see data for Dalhart fine sandy loam, 1 to 3 percent slopes; for Mansker soils, see data for Mansker loam, 1 to 3 percent slopes.								

TABLE 6.—*Brief description of soils in Carson*

Map symbol	Soil	Site and soil description	Typical profile: Depth	Typical profile: Horizon	Classification: USDA texture	Classification: AASHO
			Inches			
Gr	Gravelly rough land	Consists of gravelly hills between the deposits of the erosional plains and those of the red beds; is usually immediately above the red beds in the Canadian River breaks; material is sand and small and large pebbles and cobbles underlain by soft sandstone, a layer of hard limestone, or both; limestone may range from a few inches to 5 feet in thickness.	Usually a coarse sand and gravel A-1 mantle, 6 to 12 inches in depth, underlain by fine to coarse sand grading to soft sandstone.			
Lk	Likes loamy fine sand, hummocky.	24 to 40 inches of coarse-grained, well-drained soil; noncalcareous at the surface to strongly calcareous at 40 inches or more; highly susceptible to wind erosion and occurs in many bare or scalded spots.	0–9	A_1	Loamy fine sand	A–2
			9–40	AC	Loamy fine sand	A–2
			40–78	C	Fine sandy loam	A–2
Lo	Lofton silty clay loam	36 to 72 inches of fine-textured soil, usually in a band around and above the bottom of playas; noncalcareous at the surface to strongly calcareous at the C_{cab} horizon; very similar to Pullman silty clay loam except for position and slightly darker color.	0–6	A_{1p}	Silty clay loam	A–6
			6–15	B_{21}	Clay	A–7–6
			15–64	B_{22}	Silty clay	A–7–6
			64–72	B_{2b}	Silty clay	A–7–6
			72–80	C_{cab}	Clay loam	A–6
Ls	Lofton and Church soils	Occur in playas above Randall clay and below Lofton silty clay loam; deep, heavy clay soils; calcareous to the surface; considerable expansion caused by wetting and drying; profile is for a Church soil (profile for Lofton soil described under Lofton silty clay loam).	0–4	A_{11}	Silty clay	A–7–6
			4–40	A_{12}	Clay	A–7–6
			40–58	AC	Clay	A–7–6
			58–80	C_{ca}	Clay	A–7–6
MkB MkC MkC2	Mansker loam, 1 to 3 percent slopes. Mansker loam, 3 to 5 percent slopes. Mansker loam, 3 to 5 percent slopes, eroded.	Usually occur in the upper part of the transitional area between the High Plains and the Rolling Plains; also occur as a complex or in association with Berthoud, Dalhart, and Potter soils. From 10 to 20 inches of fine- to coarse-grained, well-drained, shallow soil, strongly calcareous to the surface.	0–9	A	Loam	A–4 or A–6
			9–17	AC	Clay loam	A–4 or A–6
			17–35	C_{ca}	Clay loam	A–4 or A–6
			35–48	C	Sandy clay loam.	A–4
	Mansker fine sandy loam, 3 to 8 percent slopes.	Usually occurs on the upper slopes of rolling hills and knolls that are in most places capped by small areas of Potter soils. Shallow, calcareous, well-drained sandy soils; in this county mapped only as an undifferentiated unit with Berthoud fine sandy loam.	0–12	A_1	Fine sandy loam.	A–2 or A–4
			12–18	AC	Sandy clay loam.	A–4
			18–48	C_{ca}	Clay loam	A–4 or A–6
			48–65	C	Clay loam	A–4 or A–6
OcB OcC	Olton clay loam, 1 to 3 percent slopes. Olton clay loam, 3 to 5 percent slopes.	Usually occur below Pullman soils of the High Plains and above the Dalhart soils; generally more permeable than Pullman soils and less permeable than Dalhart soils; deep, mature; noncalcareous at the surface to calcareous at the C_{ca} horizon.	0–9	A_1	Sandy clay loam.	A–6
			9–25	B_2	Clay loam	A–6 or A–7–6.
			25–51	B_3	Sandy clay loam.	A–6
			51–70	C_{ca}	Sandy clay loam.	A–6
			70–84+	C	Sandy clay loam.	A–6

See footnotes at end of table.

County, Tex., and their estimated physical properties—Continued

Classification—Continued	Percentage passing sieve [1]—			Permeability [2 3]	Available water [2 3]	Reaction (pH value) [3]	Dispersion [2 3]	Shrink-swell potential [2 3]
Unified	No. 4 (4.76 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)					
				Inches per hour	*Inches per foot of depth*			
GW to SW	50–75	20–60	5–20	1. 0–2. 0	0. 5–1. 0	6. 0–7. 0	Low	Low.
SM	99–100	95–100	12–45	1. 0–2. 0	1. 4–1. 6	6. 5–8. 0	Low	Low.
SM	------	------	------	------	1. 4–1. 6	------	------	
SM	------	------	------	------	1. 4–1. 6	------	------	
CL								
CH or MH								
CH or MH	99–100	99–100	85–100	0. 1–0. 5	1. 5–2. 4	6. 5–8. 0	Low to moderate.	Moderate to high.
CL or CH								
CL								
CL								
CH or MH	99–100	95–100	80–100	0. 10–0. 50	2. 4–1. 5	6. 5–8. 5	Low to moderate.	Moderate to high.
CH or MH								
CH or MH								
SC or CL	97–100	95–100	40–75					
SC or CL	97–100	95–100	45–90	0. 5–1. 0	1. 5–2. 0	7. 0–8. 5	Low to moderate.	Low to moderate.
SC or CL	97–100	95–100	45–90					
SC or CL	97–100	95–100	40–75					
SM or SC	90–100	85–95	30–50					
SC or CL	90–100	85–95	40–65	0. 75–1. 25	0. 8–2. 0	7. 0–8. 5	Low	Low.
SC or CL	90–100	85–95	45–70					
SC or CL	90–100	85–95	45–70					
CL								
CL								
CL	99–100	95–100	80–90	0. 2–0. 5	1. 5–2. 0	6. 0–7. 5	Low to moderate.	Moderate.
CL								
CL								

TABLE 6.—*Brief description of soils in Carson*

Map symbol	Soil	Site and soil description	Typical profile		Classification	
			Depth	Horizon	USDA texture	AASHO
			Inches			
Ps	Potter soils	Usually occur along the escarpment areas between the High Plains and the Rolling Plains; generally underlain by lime-cemented beds of caliche or calcareous sandstone; some of the caliche and sandstone beds are 5 or more feet thick and hard in many places; occur also as complexes or in association with Mansker and Berthoud soils; very shallow, medium textured, strongly calcareous to the surface.	0–9	A_1	Fine sandy loam.	A–4 to A–6
			9–32	C	Caliche	
PuA	Pullman silty clay loam, 0 to 1 percent slopes.	These soils occupy about 80 percent of the hardlands of the High Plains area; fine-grained soils that range from 24 to 75 inches in depth; noncalcareous at the surface to strongly calcareous at the C_{ca} horizon; color grayish brown to dark grayish brown; the major part of the acreage has slopes that range from 0 to 1 percent; normal slope is generally from west to east except where influenced by local drainage.	0–7	A_{1p}	Silty clay loam	A–6
PuB	Pullman silty clay loam, 1 to 3 percent slopes.		7–17	B_{21}	Clay	A–7–6
PuB2	Pullman silty clay loam, 1 to 3 percent slopes, eroded.		17–33	B_{22}	Clay	A–7–6
			33–48	B_{ca} or B_{23}.	Clay	A–7–6
			48–75	B_{2b}	Silty clay	A–7–6
			75–95+	C_{cab}	Silty clay	A–7–6
Ra	Randall clay	Usually occurs in the bottom of playas; generally 4 to 6 feet of poorly drained clay or silty clay underlain by calcareous clay or caliche.	0–10	A_{11}	Clay	A–7–6
			10–20	A_{12}	Clay	A–7–6
			20–50	AC	Clay	A–7–6
			50–65	C	Clay	A–7–6
RcB	Richfield clay loam, 1 to 3 percent slopes.	Developed from old calcareous alluvium or plains outwash material on erosional terraces; deep, dark, heavy textured; noncalcareous at the surface to strongly calcareous at the C_{ca} horizon.	0–7	A_1	Clay loam	A–6
			7–18	B_1	Clay	A–6
			18–32	B_{21}	Clay	A–7–6
			32–42	B_{22}	Clay	A–7–6
			42–54	B_3	Clay	A–6
			54–72	C_{ca}	Sandy clay	A–6
			72–84+	C	Sandy clay loam	A–6
Ro Rs	Rough broken land Rough stony land.	These miscellaneous land types are similar in appearance and differ mainly in location; Rough broken land makes up the upper breaks between the High Plains and the Rolling Plains, whereas Rough stony land occurs immediately above the red beds; both are steep limestone or caliche escarpments that may range from 1 foot to 6 or more feet in thickness; these escarpments break off as large boulders or flags and fall on the slopes below.			Rock or caliche boulders underlain by sandy loam to clay loam.	
Sc Sp	Spur clay loam Spur fine sandy loam.	Developed from alluvium deposited as flood plains along the channel of draws; some areas no longer flooded; well-drained, nearly level soils; deep, dark, and slightly calcareous at the surface grading to strongly calcareous; may have lenses of water-deposited sand or gravel throughout the profile; below and adjacent to Bippus soils in many places. (Spur fine sandy loam is similar to Spur clay loam in location and profile; differs mainly in having a sandier surface soil.)	0–5	A_{11}	Clay loam	A–4
			5–13	A_{12}	Clay loam	A–4
			13–22	AC	Clay loam	A–6 or A–7
			22–72	C	Clay	A–6 or A–2

See footnotes at end of table.

County, Tex., and their estimated physical properties—Continued

Classification—Continued	Percentage passing sieve [1]—			Permeability [2 3]	Available water [2 3]	Reaction (pH value) [3]	Dispersion [2 3]	Shrink-swell potential [2 3]
Unified	No. 4 (4.76 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)					
				Inches per hour	*Inches per foot of depth*			
SM or SC to CL	95–100	85–100	45–90	0. 5–0. 9	0. 8–1. 5	7. 0–8. 5	Low	Low to moderate.
CL		100	96	0. 05–0. 5	1. 5–2. 4	6. 0–8. 0	Low to moderate.	Moderate to high.
CL or CH		100	90–95					
CH		100	96					
CH		100	90–95					
CL		100	85–92					
CL		100	85–95					
CH	100	100	70–90	0. 05–0. 3	2. 0–2. 5	6. 0–8. 0	Moderate to high.	High.
CH			70–90					
CH			70–90					
CH			70–90					
CL	90–100	85–95	60–90	0. 2–0. 5	2. 0–2. 4	6. 0–8. 0	Low to moderate.	Moderate to high.
CL or CH	98–100	85–95	60–90					
CL or CH	98–100	85–95	70–90					
CL or CH	98–100	85–95	70–90					
CL or CH	98–100	85–95	60–90					
CL	98–100	85–95	55–75					
CL	98–100	85–95	55–75					
ML	95–100	90–100	70–90	0. 3–0. 5	1. 5–2. 0	6. 5–8. 0	Low to moderate.	Low to moderate.
ML	95–100	90–100	70–90					
CL	95–100	90–100	80–90					
CL	95–100	90–100	80–90					

TABLE 6.—*Brief description of soils in Carson*

Map symbol	Soil	Site and soil description	Typical profile		Classification	
			Depth	Horizon	USDA texture	AASHO
			Inches			
Tv	Tivoli fine sand	Developed mainly from eolian sediments; usually occurs as sand dunes that support vegetation; deep, coarse grained, well drained; generally noncalcareous; very little runoff.	0–8 8–72+	A C	Fine sand Fine sand	A–2 A–2
UcA UcB UcB2	Ulysses clay loam, 0 to 1 percent slopes. Ulysses clay loam, 1 to 3 percent slopes. Ulysses clay loam, 1 to 3 percent slopes, eroded.	Usually occur as low ridges in larger bodies of Pullman soils; developed on the High Plains from calcareous deposits of loess in fine-textured soils of medium depths; well drained, calcareous to the surface; highly susceptible to wind erosion when not protected by vegetation.	0–8 8–25 25–40 40–65+	A_1 AC C_{ca} C	Clay loam Clay loam Clay loam Clay loam	A–6 A–6 A–6 A–6
VoB	Vona fine sandy loam, 1 to 3 percent slopes.	Occurs in smooth draws or flats between Spring and Dixon Creeks; formed from recent outwash material that may have been shifted by wind; mature, deep, well-drained soil; noncalcareous at the surface to strongly calcareous at the C_{ca} horizon.	0–18 18–26 26–36 36–46 46–74	A_1 B_1 B_2 B_3 C_{ca}	Fine sandy loam Fine sandy loam Sandy clay loam Sandy clay loam Loam	A–4 A–4 A–6 A–6 A–4 or A–6
ZcA ZcB	Zita clay loam, 0 to 1 percent slopes. Zita clay loam, 1 to 3 percent slopes.	Usually occur around the upper slope breaks around playas and drainageways; generally adjacent to or surrounded by Pullman soils; deep, fine-textured soils; noncalcareous at the surface to strongly calcareous at the C_{ca} horizon; highly susceptible to wind erosion when not protected by vegetation.	0–8 8–22 22–38 38–63 63–80	A_{1p} A_{12} AC C_{ca} D	Clay loam Silty clay loam Silty clay loam Sandy clay loam Clay	A–7–6 A–7–6 A–7–6 A–6 A–7–6

[1] Except where data are given for separate horizons, percentage passing sieve is a range for all horizons.

[2] Estimates based on knowledge of Soil Conservation Service personnel familiar with soils of the county.

County, Tex., and their estimated physical properties—Continued

Classification—Continued: Unified	Percentage passing sieve [1]—: No. 4 (4.76 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	Permeability [2 3]	Available water [2 3]	Reaction (pH value) [3]	Dispersion [2 3]	Shrink-swell potential [2 3]
				Inches per hour	*Inches per foot of depth*			
SP or SM	100	85-95	10-35	2.0-2.5	1.0-1.5	6.0-7.0	Low	Low.
SP or SM	100	85-95	10-35					
CL	98-100	93-100	59-90	0.5-0.9	1.5-2.0	7.0-8.0	Low	Low.
CL								
CL								
CL								
SM	95-100	85-95	45-85	1.5-2.0	1.5-1.8	6.0-8.0	Low	Low.
SM	95-100	85-95	40-50					
SC or CL	95-100	85-95	45-70					
SC or CL	95-100	85-95	45-70					
SC or CL	95-100	85-95	45-65					
CL	99-100	95-100	90-100	0.5-0.9	1.5-2.0	6.0-8.0	Low to moderate.	Low to moderate.
CL								
CL								
CL								
CL								

[3] Generalized values for all horizons listed.

TABLE 7.—*Interpretations of*

Map symbol	Soil [1]	Adaptability to grading in winter	Suitability of soil material for—		Suitability as a source of topsoil	Suitability for vertical alinement of highways	
			Road subgrade	Road fill		Materials	Drainage
Au	Alluvial land	Fair	Fair	Fair to good	Fair	Poor; subgrade may consolidate.	Good; subject to overflow in place.
BeC	Berthoud fine sandy loam, 3 to 5 percent slopes.	Fair	Fair	Fair	Fair	Good	Good
BfD	Berthoud and Mansker fine sandy loams, 3 to 8 percent slopes.	Good	Fair	Fair to good	Fair; Mansker is a shallow soil.	Good	Good
BrB	Bippus clay loam, 1 to 3 percent slopes.	Fair	Fair	Fair	Fair to good	Good	Good
DaB	Dalhart fine sandy loam, 1 to 3 percent slopes.	Good	Fair to good	Fair	Fair to good	Good	Good
DaC	Dalhart fine sandy loam, 3 to 5 percent slopes.	Good	Fair to good	Fair	Fair to good	Good	Good
DmC	Dalhart-Mansker loams, 3 to 5 percent slopes.	Good	Fair to good	Fair to good	Fair to good	Good	Good
Gr	Gravelly rough land.[2]	Good	Good to poor; hard limestone subsurface may be a problem.	Fair; needs fines added; hard limestone may be a problem.	Not suited	Needs fines added.	Good
Lk	Likes loamy fine sand, hummocky.	Good	Fair	Fair to good; needs topsoil cover to prevent wind and water erosion.	Poor	Fair; highly erodible.	Good

See footnotes at end of table.

engineering properties of the soils

Stability for dikes and levees	Features that affect the construction of farm ponds—		Suitability for agricultural engineering practices			
	Reservoir area	Embankments	Irrigation	Land leveling	Terraces and diversions	Waterways
Fair; erosive	Moderately permeable; will seal.	May be poor foundation for fill; good fill material when compacted.	Poor; used mainly for range.	Not suited	Suitable	Suitable.
Fair	Moderately permeable; will seal.	Fair stability; well graded.	Poor; used mainly for range.	Not suited	Suitable; diversions may be needed to protect more level land below.	Suitable; will support vegetation.
Fair	Will usually seal; strongly calcareous lower subsoil.	Good stability; well graded.	Poor; used mainly for range.	Not suited	Suitable; diversions may be needed to protect smooth land below.	Suitable; will support vegetation.
Fair	Moderately permeable; will seal.	Good stability; well graded.	Suitable for surface or sprinkler system; soil productive.	Suitable; soil deep.	Suitable; generally needed to control erosion; level or graded terraces satisfactory.	Suitable; will support vegetation; needed as terrace outlet, also to control outside runoff.
Fair	Moderately permeable; strongly calcareous lower subsoil; will seal.	Fair stability; well graded.	Suitable for surface or sprinkler system; moderately permeable; soil productive.	Suitable; soil deep; wind erosion may be a problem.	Suitable; may be needed to control erosion; level or graded terraces may be used.	Suitable; will support adequate vegetation to control erosion; no construction problem.
Fair	Strongly calcareous lower subsoil; will seal.	Fair stability; well graded.	Poor; used mainly for range.	Not suited; steep slopes make leveling costs high.	Suitable	Suitable; will support adequate vegetation to control erosion; no construction problem.
Fair	Strongly calcareous lower subsoil; will seal.	Fair stability; well graded.	Poor; used mainly for range.	Not suited; soil shallow; topography rough.	Suitable	Suitable; will support adequate vegetation unless deep cuts are required.
Poor; needs binders for stability; wind erosion is a problem.	Not suited unless red bed is at or near the surface in the reservoir area.	Not suited unless a clay material is added as a binder.	Not suited; used mainly for range.	Not suited	Not suited; used mainly for range.	Not suited.
Poor; not suited unless a binder is added.	Not suited unless an impermeable blanket is used.	Not suited unless a binder is added.	Not suited; used mainly for range.	Not suited	Not needed	Not needed.

TABLE 7.—*Interpretations of engineering*

Map symbol	Soil [1]	Adaptability to grading in winter	Suitability of soil material for—		Suitability as a source of topsoil	Suitability for vertical alinement of highways	
			Road subgrade	Road fill		Materials	Drainage
Lo	Lofton silty clay loam.	Poor; difficult to work when wet or frozen.	Poor	Poor	Fair to good	Poor; high shrink-swell potential.	Fair
Ls	Lofton and Church soils.	Poor; difficult to work when wet or frozen.	Poor	Poor	Fair to good	Poor; high shrink-swell potential.	Fair to poor
MkB	Mansker loam, 1 to 3 percent slopes.[3]	Fair	Fair to good	Fair to good	Surface 6 to 12 inches is good.	Fair to good	Good
MkC	Mansker loam, 3 to 5 percent slopes.[3]	Fair	Fair to good	Fair to good	Surface 6 inches is good.	Fair to good; hard caliche in places.	Good
MkC2	Mansker loam, 3 to 5 percent slopes, eroded.	Fair	Fair to good	Fair to good	Poor to fair	Fair to good; hard caliche in places.	Good
	Mansker fine sandy loam, 3 to 8 percent slopes.[4]						
Mx	Mansker-Potter-Berthoud sandy loams.[3]	Fair	Fair to good; layer of hard limestone may underlie Potter soils.	Fair to good	Surface 6 inches is fair.	Fair to good	Good
OcB OcC	Olton clay loam, 1 to 3 percent slopes. Olton clay loam, 3 to 5 percent slopes.	Fair	Fair	Fair	Good	Poor to fair	Fair to good
Ps	Potter soils[3]	Fair	Fair to good; may be underlain by a layer of hard limestone.	Fair; may be rocky.	Poor; shallow soils.	Fair; hard caliche in places.	Good

See footnotes at end of table.

properties of the soils—Continued

Stability for dikes and levees	Features that affect the construction of farm ponds—		Suitability for agricultural engineering practices			
	Reservoir area	Embankments	Irrigation	Land leveling	Terraces and diversions	Waterways
Poor; poorly graded; cracks easily.	Very slowly permeable; strongly calcareous lower subsoil; will seal.	Fair stability; good core or blanket material.	Poorly suited; very slowly permeable; difficult to irrigate adequately because of low intake rate.	Limited suitability; will need soil conditioning in cut areas.	Limited suitability; needed on slopes steeper than 1 percent to control ersoion; subject to cracking; graded terraces preferable.	Suitable; construction not a problem; will support adequate vegetation; needed for terrace outlets.
Poor; poorly graded; cracks easily.	Very slowly permeable; are generally good for dug ponds.	Fair stability; strongly calcareous.	Generally not irrigated because of location in playas.	Limited suitability; will need soil conditioning in cut areas.	Suitable; generally needed because soil is close to the bottom of playa.	Fairly well suited; will support vegetation; drowning of vegetation is a problem.
Good; well graded.	Moderately permeable; strongly calcareous; will seal.	Fair stability; well graded.	Limited suitability; moderately permeable, shallow soil; may use either surface or sprinkler system.	Limited suitability; shallow soil; will need conditioning in cut areas.	Suitable; generally needed on slopes exceeding 1 percent; level or graded terraces satisfactory.	Fairly well suited; generally needed; will support adequate vegetation to control erosion if cuts are shallow.
Good; well graded.	Moderately permeable; strongly calcareous; will seal.	Fair stability; well graded.	Poor; moderately permeable; used mainly for range.	Not suited; shallow soil; expensive to level.	Suitable; generally not needed on range.	Fairly well suited; material satisfactory; will support adequate vegetation if cuts are very shallow.
Good; well graded.	Moderately permeable; strongly calcareous; slow to seal.	Fair stability; well graded.	Poor; moderately permeable; used mainly for range.	Not suited	Suitable; generally not needed on range.	Not suited; shallow soil.
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Good; well graded.	Moderately permeable; strongly calcareous; may be slow to seal.	Good stability; well graded.	Not suited; used mainly for range.	Not suited	Material satisfactory; generally not needed on range.	Not suited; shallow soils.
Good; fine-textured soils.	Slowly permeable; strongly calcareous in lower subsoil; will seal.	Fair stability for low fills; good core or blanket material.	Limited suitability; surface system generally used; slowly permeable; soil productive.	Suitable	Suitable; needed on slopes above 1 percent; slightly graded terraces suggested.	Suitable; no construction problem; will support adequate vegetation to control erosion.
Not suited; shallow; may be stony.	Moderately permeable; strongly calcareous; may be stony; may not seal.	Fair stability; may be rocky.	Not suited; soils very shallow; used mainly for range.	Not suited	Not suited; very shallow and stony.	Not suited; very shallow and stony.

TABLE 7.—*Interpretations of engineering*

Map symbol	Soil [1]	Adaptability to grading in winter	Suitability of soil material for—		Suitability as a source of topsoil	Suitability for vertical alinement of highways	
			Road subgrade	Road fill		Materials	Drainage
PuA PuB PuB2	Pullman silty clay loam, 0 to 1 percent slopes Pullman silty clay loam, 1 to 3 percent slopes. Pullman silty clay loam, 1 to 3 percent slopes, eroded.	Poor; difficult to work when wet or frozen.	Poor	Poor to fair	Good	Poor; fairly high shrink-swell potential.	Slow surface drainage on level areas.
Ra	Randall clay	Poor; difficult to work when wet or frozen.	Poor	Poor	Poor	Poor; high shrink-swell potential.	Poor; is in bottoms of playas.
RcB	Richfield clay loam, 1 to 3 percent slopes.	Poor; difficult to work when wet or frozen.	Poor	Poor to fair	Good	Poor	Good
Ro Rs	Rough broken land [3] Rough stony land.[3]	Good	Poor; generally not suited because of rocks and boulders.	Poor	Not suited	Fair; hard caliche in places.	Good
Rw	Riverwash	Good	Good to poor	Good to fair	Not suited	Good to fair	Good to poor
Sc Sp	Spur clay loam Spur fine sandy loam.	Good	Fair to good	Fair to good	Good	Fair to good	Good
Tv	Tivoli fine sand	Good	Good	Fair; needs fines added.	Generally unsuitable because of sand; susceptible to wind erosion.	Fair; highly erodible.	Good

See footnotes at end of table.

properties of the soils—Continued

Stability for dikes and levees	Features that affect the construction of farm ponds—		Suitability for agricultural engineering practices			
	Reservoir area	Embankments	Irrigation	Land leveling	Terraces and diversions	Waterways
Poor; very slowly permeable; poorly graded.	Very slowly permeable; strongly calcareous in lower subsoil; will seal.	Fair stability for low fills; good core or blanket material.	Limited suitability; best suited to surface system; very slowly permeable; high water-holding capacity; soils very productive.	Suitable; will need conditioning on cut areas.	Suitable; needed on slopes above 1 percent; slightly graded terraces suggested.	Suitable; no construction problem; will support adequate vegetation to control erosion; needed for terrace outlets.
Poor; very slowly permeable; poorly graded; cracks easily.	Very slowly permeable; generally suitable for dug ponds only because soil is in bottoms of playas.	Fair stability	Poorly suited; generally not irrigated because of location.	Generally not leveled because of location.	Not needed	Not needed.
Good; adequate stability.	Slowly permeable; strongly calcareous in lower subsoil; will seal.	Fair stability for low fills; good core and blanket material.	Limited suitability; best suited to a surface system; slowly permeable; soil productive.	Suitable	Suitable; no construction problem; needed on long slopes and on slopes above 1 percent; slightly graded terraces preferable.	Suitable; no construction problem; will support adequate vegetation to control erosion; needed for terrace outlets.
Not suited because of rock.	Moderately permeable; strongly calcareous; may not seal.	Poorly suited; rock and boulders make it difficult to obtain adequate embankment material.	Not suited	Not suited	Not suited	Not suited.
Poor to fair	Most areas not suited unless covered by impermeable blanket, or unless underlain by strongly calcareous material.	Most areas not suited unless fines are added.	Not suited	Not suited	Not suited	Not suited.
Good; adequate stability.	Moderately permeable; strongly calcareous in lower subsoil; will seal.	Good stability; well graded; core needed because of sand and gravel strata throughout profile.	Suitable for surface or sprinkler system; moderately permeable.	Suitable	Suitable; diversions may be needed to protect from outside water; terraces not required.	Suitable; no construction problem; will support adequate vegetation to control erosion.
Very poor unless fines are added.	Not suited unless covered by blanket of impermeable material.	Not suited unless fines are added.	Not suited; used mainly for range.	Not suited; susceptible to wind erosion.	Not suited	Not suited.

TABLE 7.—*Interpretations of engineering*

Map symbol	Soil [1]	Adaptability to grading in winter	Suitability of soil material for—		Suitability as a source of topsoil	Suitability for vertical alinement of highways	
			Road subgrade	Road fill		Materials	Drainage
UcA	Ulysses clay loam, 0 to 1 percent slopes.	Good	Fair	Fair to good	Good	Fair to good	Good
UcB	Ulysses clay loam, 1 to 3 percent slopes.						
UcB2	Ulysses clay loam, 1 to 3 percent slopes, eroded.						
VoB	Vona fine sandy loam, 1 to 3 percent slopes.	Good	Fair to good	Fair to good	Fair; susceptible to wind erosion.	Fair to good	Good
ZcA	Zita clay loam, 0 to 1 percent slopes.	Poor; difficult to work when wet or frozen.	Fair	Fair	Good	Fair	Poor; surface drainage on level areas.
ZcB	Zita clay loam, 1 to 3 percent slopes.						

[1] The Mansker, Potter, and Berthoud soils are associated with each other in many places. They may be mapped as complexes or as undifferentiated units that have the characteristics of each of the components.

[2] Although some small areas of commercial sand and gravel may be in Gravelly rough land, these areas have not been developed.

properties of the soils—Continued

Stability for dikes and levees	Features that affect the construction of farm ponds—		Suitability for agricultural engineering practices			
	Reservoir area	Embankments	Irrigation	Land leveling	Terraces and diversions	Waterways
Suitable; stability adequate.	Moderately permeable; calcareous throughout the profile; will generally seal by siltation.	Fair stability; fairly well graded.	Suitable for surface or sprinkler system; moderately permeable; moderate water-holding capacity.	Suitable; may be expensive on steeper slopes.	Suitable; no construction problem; may be needed to control erosion; terraces may be level or graded.	Suitable; no construction problem; will support adequate vegetation to control erosion.
Suitable; stability adequate; susceptible to wind erosion.	Moderately permeable; strongly calcareous in lower subsoil; generally slow to seal.	Good stability; well graded; seepage may be fairly high.	Limited suitability; best suited to sprinkler system; moderately to moderately rapidly permeable; generally used for range.	Limited suitability; can be leveled but is susceptible to wind erosion; used mainly for range.	Limited suitability; diversions may be needed to protect from outside water; terraces usually not suggested.	Suitable; no construction problem; will support adequate vegetation to control erosion.
Suitable; stability adequate.	Moderately permeable; strongly calcareous in lower subsoil; will seal.	Fair stability; fairly well graded.	Limited suitability; best suited to a surface system; moderately permeable; soils very productive.	Suitable; susceptible to wind erosion.	Suitable; may be needed on long slopes or on slopes above 1 percent; no construction problem; terraces may be level or graded.	Suitable; no construction problem; will support adequate vegetation to control erosion.

[3] The Potter and Mansker soils, Rough broken land, and Rough stony land are generally underlain at a shallow depth by caliche, which is suitable as a base for flexible paving.

[4] In this county mapped only as an undifferentiated unit with Berthoud fine sandy loam.

Winter grading causes little or no problem on most of the soils in the county. The moderately fine textured to fine textured soils, such as Pullman, Randall, Lofton, Zita, and Church, are hard to break when frozen. Because of the high water-holding capacity and slow permeability rate, these soils, when wet, are difficult to dry enough to be worked. Subfreezing temperatures and wet weather do not often occur for long periods and therefore are not a major problem.

The fine and moderately fine textured soils are very soft and sticky when wet, and it is impractical to move equipment across them except when the ground is dry.

Practically all of the soils in Carson County are suitable for fill material, if they are properly placed and compacted. The sandy surface layer of some soils should be graded with the heavier layers of the soil profile to make the best fill material. Because the Pullman, Lofton, Randall, and Church soils have a relatively high volume change when they become wet or dry, and because of their plasticity when wet, the gradeline should be set at or above the ground surface unless good surface drainage is provided. Also because of this high volume change and plasticity, special precautions are necessary when concrete structures are planned on these soils.

Bedrock is not likely to occur beneath the soils in this county. Potter and Mansker soils and Rough broken land and Rough stony land are usually underlain by caliche beds. Some of this caliche may be hard enough to require blasting. When construction is required on these mapping units, local investigation is needed.

With few exceptions the surface layer of the soils in the county is suitable for use as topsoil for growing plants. Some soils, such as the Potter, are very shallow, and some sandy soils, such as the Likes and Tivoli, are subject to wind erosion.

Drainage is not considered a problem on most soils in Carson County. Pullman, Lofton, Randall, and Church soils are slowly or very slowly permeable. Because of flat slopes, Pullman soils usually have slow surface drainage. Randall soils occur in playas and have no surface drainage.

The general slope of the land is from west to east except where it is influenced by local drainage. Drainage from the High Plains is mainly to playas through very poorly defined drainageways. The need for development of drainage systems increases as land use becomes more intense.

Ponds constructed in most of the soils of the county, except the very sandy soils, such as those of the Likes and

TABLE 8.—*Engineering*

[Leaders indicate that reliable

Soil name	Parent material	Depth	Horizon	Shrinkage			Field moisture equivalent	Specific gravity
				Limit	Ratio	Lineal		
Bippus clay loam, 1 to 3 percent slopes:		*Inches*						
5¼ miles north and ¾ mile east of Panhandle (modal).	Local alluvium	0–14	A_1	16	1.77	4.6	24	2.66
		27–50	C_{ca}	14	1.90	4.0	18	2.66
4¾ miles north and ⅓ mile east of Panhandle (finer texture).	Local alluvium	0–14	A_1	16	1.79	8.1	27	2.67
		29–50	AC_2	15	1.86	8.7	23	2.68
13 miles north and 1 mile west of Panhandle (coarse textured).	Local alluvium	0–14	A_1	16	1.78	3.7	21	2.64
		34–45	C_{ca}	16	1.84	8.5	21	2.72
Mansker clay loam, 1 to 3 percent slopes:								
11¼ miles north and 1¼ miles west of Panhandle (modal).	Medium- to fine-textured sediments.	0–9	A_1	17	1.77	17	24	2.68
		17–35	C_{ca}	17	1.74	17	24	2.68
3¼ miles east of Conway (finer textured).	Eolian sediments	0–10	A_p	18	1.76	10.7	33	2.67
		14–42	C_{ca}	17	1.79	7.7	23	2.70
Mansker sandy clay loam:								
3½ miles east and 12 miles north of Panhandle (coarser textured).	Medium-textured sediments.	0–10	A_1	18	1.72	18	23	2.68
		19–35	C_{ca}	18	1.72	18	25	2.65
Ulysses clay loam, 3 to 5 percent slopes, eroded:								
6 miles west and 2 miles north of Panhandle (modal).	Eolian sediments	0–13	A_{1p}, A_{12}	15	1.83	11.0	31	2.68
		24–54	C_{ca}	15	1.84	9.7	27	2.69
5 miles west and ¼ mile north of Panhandle (finer textured).	Eolian sediments	0–13	A_{1p}, A_{12}	15	1.84	12.9	31	2.65
		27–48	C_{cal}	13	1.92	13.7	27	2.66
3 miles south and ¾ mile west of Lee's switch (coarse textured).	Eolian sediments	4–11	A_{12}	16	1.82	8.2	25	2.69
		11–34	AC	16	1.79	8.8	27	2.70

[1] Tests performed by Texas Highway Department in accordance with standard procedures of the American Association of State Highway Officials (AASHO) (*1*).

[2] Mechanical analyses according to the American Association of State Highway Officials Designation: T 88. Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the

Vona series, will gradually seal because of siltation and trampling by livestock. If it is necessary for a pond to hold water immediately after construction, special treatment is usually needed, such as the placing of an impermeable blanket.

Most of the soil in Carson County is underlain by a permeable calcareous material. This material may occur near the surface or be as deep as 10 feet, but the average depth ranges from 2 to 4 feet. It will usually seal because of siltation and trampling by livestock and therefore can be used for reservoirs or ponds. This permeable material provides excellent internal drainage for crop production, particularly under irrigation.

The majority of the irrigated land at present is on soils of the Pullman series. These soils are very slowly permeable. Some small areas of other soils of other series are irrigated. Surface irrigation systems (level or graded borders and level or graded furrows) are usually needed for slowly and very slowly permeable soils. On the other hand, sprinkler systems are needed for either rapidly permeable soils or soils on rough topography. The moderately permeable soils may be irrigated satisfactorily by either method. The cost of leveling is a major problem on the steeper slopes.

Irrigation is gradually increasing; however, the expansion is fairly slow because the irrigation wells are comparatively deep. The average static water level is at a depth of approximately 320 feet. If drawdown is added to this depth, pumping costs are usually high.

Waterways and diversion and other terraces can be constructed satisfactorily on most soils. Establishment of grass in waterways is often a problem because of lack of rainfall at the proper time. Diversion or other terraces on Pullman, Lofton, Olton, and Richfield soils usually should be constructed with a slight grade, and provision should be made for an outlet. Terraces on other soils may be either level or graded.

Additional Facts About the County

Climate

The Panhandle region is subject to rapid and wide changes in temperature. These changes occur especially during the winter months when masses of cold air generate over the Northern Plains States and prairie Provinces of Canada and surge southward over the nearly level, un-

test data [1]

test data were not available]

Mechanical analyses [2]										Liquid limit	Plasticity index	Classification	
Percentage passing sieve—						Percentage smaller than—						AASHO [3]	Unified [4]
¾ in.	⅜ in.	No. 4 (4.76 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.				
------	------	100	98	87	46	41	--------	12	10	25	7	A-4(2)	SM-SC.
------	100	99	98	81	34	33	--------	18	15	21	7	A-2-4(0)	SM-SC.
------	------	--------	100	96	73	66	--------	24	22	33	15	A-6(9)	CL.
------	100	97	95	89	72	67	--------	27	23	33	16	A-6(9)	CL.
------	------	--------	100	89	37	32	--------	24	11	23	4	A-4(0)	SM-SC.
------	100	99	98	96	54	53	--------	40	30	32	14	A-6(5)	CL.
100	99	97	95	89	46	44	--------	32	18	30	12	A-6(3)	SC.
100	99	97	95	91	43	38	--------	17	13	27	9	A-4(2)	SC.
------	------	--------	--------	100	94	86	--------	33	23	41	18	A-7-6(11)	CL.
------	------	--------	100	98	93	90	--------	63	47	32	14	A-6(11)	CL.
100	99	99	98	92	36	33	--------	10	8	24	3	A-4(0)	SM.
100	97	93	91	89	49	43	--------	19	14	29	10	A-4(3)	SC.
------	------	--------	--------	100	85	79	--------	39	33	38	18	A-6(11)	CL.
------	------	--------	100	99	89	81	--------	36	30	35	18	A-6(11)	CL.
------	------	--------	100	99	90	81	--------	44	37	41	20	A-7-6(12)	CL.
------	100	98	93	88	80	74	--------	38	32	41	21	A-7-6(13)	CL.
------	------	--------	100	99	59	51	--------	27	23	32	15	A-6(7)	CL.
------	------	--------	100	99	72	65	--------	34	27	35	17	A-6(10)	CL.

pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soils.

[3] Based on Standard Specifications for Highway Materials and Methods of Sampling and Testing (Pt. 1, Ed. 7): The Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes, AASHO Designation M 145-49 (*1*).

[4] Based on the Unified Soil Classification System, Technical Memorandum No. 3-357, Volume 1, Waterways Experiment Station, Corps of Engineers, March 1953 (*7*).

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sheltered plains. There is little to impede their flow. During these outbreaks, the cold fronts, or leading edge of the advancing cold air, may move at speeds as high as 40 miles an hour. Temperature drops of 50° to 60° F., within a 12-hour period are common during winter.

According to records of the weather station at Amarillo, January is the coldest month. The average temperature is then 35.3° F. The record minimum temperature of—16° F., occurred in February 1899. The average years have 2 days when temperatures are below zero. Although very cold temperatures may occur, cold spells are likely to be shorter in Carson County than farther north. The weather that follows passage of a cold front is often clear, sunshiny, and rather pleasant. Because of low humidity, low temperatures during winter are less uncomfortable.

Temperatures average highest in July. The highest temperature recorded in the county was 108° F. It occurred on June 24, 1953. Because of a nearly constant breeze, low humidity, and high evaporation rates, the high temperatures in the daytime are usually not too uncomfortable. The high elevation and clear skies allow rapid cooling at night. For this reason the summer nights are always pleasant. Sunshine occurs about 72 percent of the time possible. Hot, drying winds occasionally do much damage to dryland crops. Average free surface evaporation during the 6 months of growing season, April through September, is 62 inches.

The average frost-free season, as recorded by the weather station at Amarillo, extends from April 17 to October 31, a period of 197 days. A growing season of slightly less than 170 days has been recorded as well as a maximum growing season of about 240 days.

The area, as a whole, has a favorable distribution of rainfall, which generally consists of frontal precipitation from the Gulf of Mexico. About three-fourths of the total precipitation falls between April and September. It is derived mostly from thunderstorms. The rains usually cover only a part of the county, but at times they may affect all of it. They come as short, hard showers that may be accompanied by strong winds and hail. Much of this rainfall is lost by runoff on the gently sloping to sloping, moderately fine textured soils. This runoff occurs mainly when the soil is compacted and protective cover is lacking. An average of 10 local hailstorms occur.

The average annual precipitation is about 22 inches. The variations from the average annual precipitation are wide and have ranged from a low of about 10 inches in 1956 to a high of 42 inches in 1923. From 1892 through 1959, precipitation was less than 15 inches in 9 years and more than 30 inches in 4 years.

In Carson County the average annual snowfall is about 12 inches. This figure varies, however, from less than 1 inch to over 30 inches. High winds cause snowfall to collect in drifts on bare cropland and heavily grazed grassland. The snowfall on stubble and on properly used grassland does not blow and drift so severely as that on bare cropland and grassland, and it provides more uniform distribution of moisture in the soil.

Good crop years do not always coincide with years of adequate or above normal rainfall. The moisture needed to produce a crop may be that in the soil from the previous year. Crop failures may occur when the average annual precipitation is normal or above normal. The rainfall at such times comes too late to benefit the crop. The timing of precipitation and the amount of stored moisture are more important in producing crops successfully than the total amount of precipitation received during the year.

The prevailing strong winds are caused by the absence of sheltering mountain ranges and the fact that Carson County is in the path of major areas of high and low pressure. An average of three to five tornadoes occur annually, and occasionally they strike points within this area.

March and April are the two windiest months. All months, however, have a mean wind velocity of more than 10 miles per hour.

Strong winds, scarcity of vegetative cover, and light winter precipitation are the causes of duststorms. During the prolonged dry period of the fifties, the drought was more intense than during the time of the Dust Bowl or dusty thirties. Since land operators are using timely and better tillage methods and larger amounts of irrigation water, they have helped considerably to reduce the intensity and number of duststorms. Figure 26 shows the frequency of duststorms limiting visibility to less than 1 mile and the precipitation patterns for Carson County.

Early History

The Comanche, Kiowa, Cheyenne, Arapahoe, and the Kiowa-Apache, warlike, nomadic Indian tribes, were in possession of the plains when the early explorers arrived. They lived mainly by hunting; the buffalo was the principal game animal.

Coronado and his men, the first white people to travel across the plains now called the Texas Panhandle, were exploring in 1541. Other expeditions were made during the next three centuries, but they left little evidence of their routes. In the 1860's and 1870's, however, a considerable number of white men hunted buffalo in the area, mainly for the hides. In 1874 the Comanche tribe made its last effort to drive the buffalo hunters from the area by making an alliance with the Kiowas, Pawnees, and Cheyennes.

In August 1876, the Texas Legislature created 55 new counties in West Texas and the Panhandle from Bexar and Young Counties. Carson County was organized in 1888. It was named in honor of Samuel P. Carson, who served as Secretary of State for the Republic of Texas.[6] The original county seat was Carson City, now called Panhandle.

In 1878 some of the first cattle were brought to Carson County from Colorado by Colonel Charles Goodnight. The scarcity of water, however, limited the number of ranches. In 1885 the first water well in the Panhandle was successfully drilled. Many small ranches were established on the High Plains after the introduction of barbed wire and windmills. From about 1915 to the present, the amount of land cultivated has increased.

[6] FORD, R. D. A SURVEY HISTORY OF CARSON COUNTY, TEXAS. 1928. [Unpublished master's thesis submitted to the Univ. Colo.]

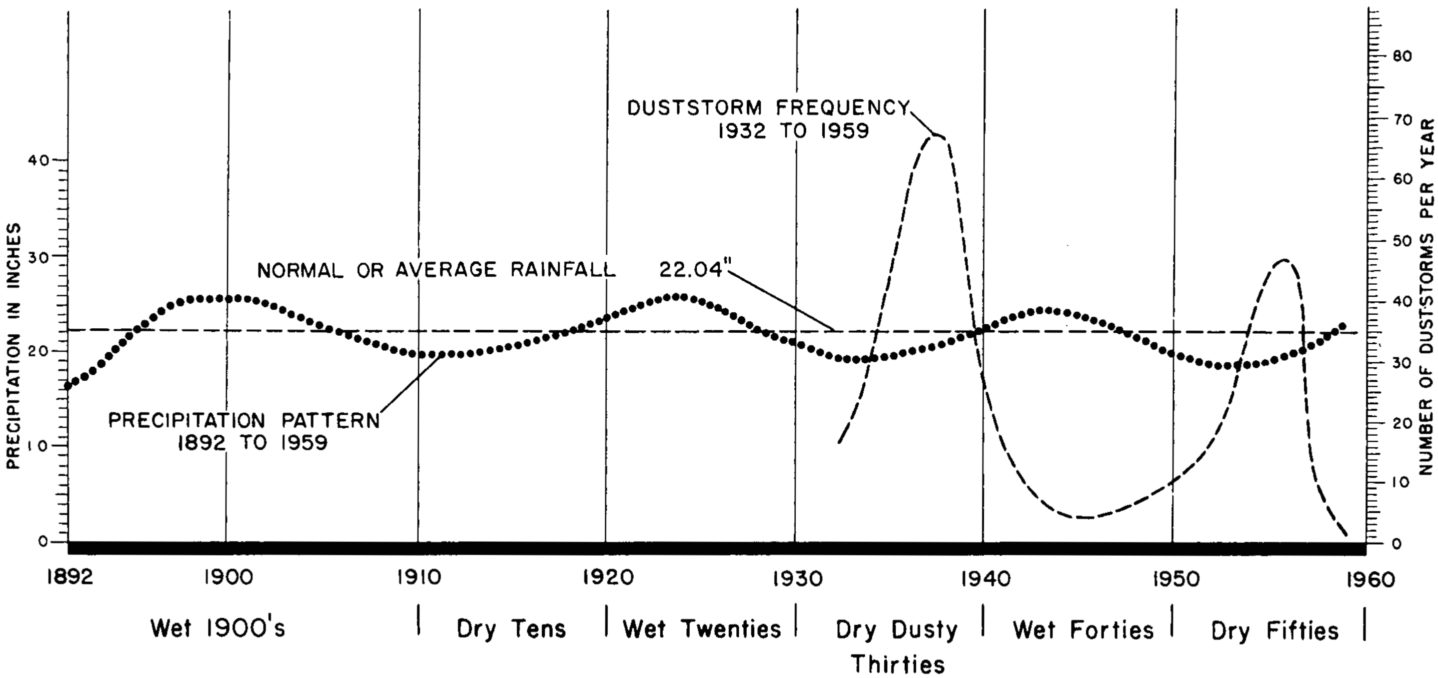

Figure 26.—**Frequency of duststorms limiting visibility to less than 1 mile, and precipitation patterns for Carson County.**

Population

In 1940 Carson County had a population of 6,624. According to the census report for 1960, the population had increased to 7,781. Panhandle, the county seat and a shipping point for wheat, cattle, and oil, had a population of 1,958 in 1960. The population of White Deer was 1,057; Skellytown, 967; and Groom, 679.

Crops

The early settlers in Carson County had a greater interest in grass than in any other crop. Later settlers from the Middle West started sowing small grain. At first they prepared the soil as in Illinois, Indiana, Iowa, and other States, but they had to modify their methods in order to conserve moisture. The one-way plow replaced the moldboard plow. Stubble mulching was also added to conserve moisture and reduce soil loss.

The acreage of the principal crops in the county is shown for stated years in table 9. All data except for 1959 were taken from the United States Census. Data for 1959 are from preliminary census reports.

Sorghum has replaced much of the wheat in Carson County because of acreage controls, but wheat is still the major crop. Wheat is irrigated when other crops do not need water. Small acreages of soybeans, sesame, barley, oats, corn, and cotton are grown.

Because of the long drought that started in the early 1950's, irrigation farming was developed. Irrigation, which began in 1953, has gradually increased.

TABLE 9.—*Acreage of principal crops in stated years*

Crops	1939	1949	1959
	Acres	*Acres*	*Acres*
Wheat threshed or combined	131, 327	205, 570	137, 500
Sorghums:			
Harvested for grain	5, 251	12, 084	--------
Cut for silage or dry forage	23, 340	8, 064	7, 560
Corn.			
All purposes	426	197	--------
Harvested for grain	50	187	--------
Barley threshed or combined	5, 369	2, 507	1, 600
Oats threshed or combined	3, 487	1, 411	1, 300
Cotton	(1)	(1)	1, 135

[1] Not reported.

Livestock

The livestock industry is of major importance in Carson County. This is because of the usually good supply of blue grama and side-oats grama on rangeland. Most of the cattle are produced for beef, but there are a few dairy cattle.

The number of livestock in Carson County in stated years is given in table 10. Data are from the United States Census.

TABLE 10.—*Number of livestock in stated years*

Livestock	1940	1950	1959
Cattle and calves	[1] 26, 450	24, 412	45, 575
Milk cows	1, 770	894	325
Hogs and pigs	[2] 2, 425	2, 342	2, 160
Sheep and lambs	[3] 3, 896	2, 555	2, 340
Horses and mules	[1] 753	580	300
Chickens	[2] 36, 133	[2] 30, 410	[4] 12, 000

[1] Over 3 months old.
[2] Over 4 months old.
[3] Over 6 months old.
[4] All poultry.

After the development of irrigation, many cattlemen who raised grass-fed cattle began feeding out at least part of their cattle. A considerable number of beef cattle are finished each year with locally grown feed.

The increase in purebred herds of cattle and other livestock in Carson County is noticeable. Some Hereford cattle have been raised here since the county was settled. Aberdeen Angus are raised in several parts of the county.

Farm Power and Mechanical Equipment

Farming in the county is becoming highly mechanized. The heavy tillage equipment, such as chisels, sweeps, one-way plows, and rotary rod weeders, are mostly drawn by large rubber-tired tractors that are powered by diesel, propane, or gasoline engines. Self-propelled combine harvesters have practically replaced the tractor-drawn combines. During the wetter years, ripe grain must be promptly harvested to avoid storm damage. Up to 60 or 70 percent of the bumper crops are custom harvested by self-propelled combines and are hauled to elevators. Fertilizer applicators, hay and silage harvesters, fuel tanks, weed sprayers, and ditchers are used in irrigated areas.

Farm Tenure and Size of Farms

Preliminary reports of the 1960 census show that 40 percent of the farms in Carson County are operated by tenants. The rest are operated by owners. Very few farms are operated by short-term tenants. Many of the tenants are relatives of the owners.

According to the United States Census, there were 463 farms in the county in 1950. The average size of the farms was 1,310 acres. Preliminary census reports for 1960 show the number of farms has increased to 653, and the average size has decreased to 860 acres. Preliminary census reports for 1960 also show that the greatest percentage increase in number of farms since 1954 has been in those that range from 70 to 259 acres in size. The number of farms of more than 1,000 acres has decreased since 1954.

The number of farms by size in 1960 was as follows: Up to 69 acres, 28; 70 to 139 acres, 21; 140 to 259 acres, 92; 260 to 999 acres, 409; and 1,000 to 30,000 acres, 103.

The ranches in the range area are much larger than the farms. One ranch, for example, has over 110,000 acres.

Public Facilities

Public facilities in Carson County include schools, churches, and highway and railroad transportation. Schools are located in Panhandle, Skellytown, White Deer, and Groom. The churches represent many denominations.

The farm and ranch roads are usually topped or surfaced with oil. A few rural roads, however, are still difficult to travel in wet weather. U.S. Highways Nos. 60 and 66 cross the county from east to west. Trucks carrying grain and livestock use these highways. Texas State Highway No. 15 extends the full length of the county. All of these highways carry much traffic. Texas Highway No. 151 connects Borger and Pampa through Skellytown. Farm and Ranch roads Nos. 293 and 294 cross the county. Other farm and ranch roads are Nos. 683 and 295. All farm-to-market roads are hard surfaced. Numerous roads connect the areas where oil and gas are produced.

The Santa Fe Railroad passes through Panhandle and connects the county with grain and livestock markets in Kansas City, Chicago, Amarillo, and Fort Worth.

Nearly all parts of the county have electricity and natural gas.

Industries

Carson County has a number of industries besides agriculture. Oil and gas production and the extraction of products from petroleum are the most important in Carson County. Natural gas pipelines leading to Denver, Chicago, St. Louis, and other metropolitan centers begin in the county. The Pantex Ordnance Plant, operated by the United States Government, is located in the western part of the county and employs several hundred workers. Various other smaller industries also provide some employment in the county. Many county residents also are employed in the oil, chemical, and aircraft industries in surrounding Potter, Hutchinson, and Gray Counties.

The first oil well was drilled in 1921 in the northwestern part of the county. New wells are continually being drilled in the Panhandle oil and gas field. The gas that contains free sulfur is used to make carbon black. The gas that is free of the sulfur is piped to Denver, Chicago, and other metropolitan centers.

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Glossary

Aggregate, soil. A single mass or cluster of soil consisting of many soil particles held together, such as a clod, prism, crumb, or granule.

Alluvium. Sand, mud, and other sediments deposited on land by streams.

Association, soil. A group of soils, with or without characteristics in common, that occur in a regular geographical pattern.

Available water. A measure of the water-holding capacity of a soil expressed in inches of water per foot of soil depth.

Azonal soils. A general group of soils having little or no soil profile development. Most of them are young. In the United States, Alluvial soils, Lithosols, and Regosols are included in the azonal group.

Calcareous soil. A soil containing calcium carbonate, or a soil alkaline in reaction because of the presence of calcium carbonate. A soil containing enough calcium carbonate to effervesce (fizz) when treated with dilute hydrochloric acid.

Caliche. A broad term for the more or less cemented deposits of calcium carbonate in many soils of warm-temperate areas, as in the Southwestern States. When it is very near the surface or exposed by erosion, the material hardens.

Cation exchange. The exchange of cations held by the soil-adsorbing complex with other cations. Thus, if a soil-adsorbing complex is rich in sodium, treatment with calcium sulfate (gypsum) causes some calcium cations to exchange with some sodium cations.

Cenozoic. The latest geologic era; it extends from the close of the Mesozoic era to and including the present.

Chisel. A tillage machine that has one or more soil-penetrating points that can be drawn through the soil to loosen or shatter the subsoil to a depth of 12 to 18 inches.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that contains 40 percent or more of clay, less than 45 percent of sand, and less than 40 percent of silt.

Clay film. A dark-colored film of fine clay that coats the surfaces and pores of soil aggregates, or peds, in many strongly developed soils. It occurs predominantly in the B horizon and consists of clay and colloids leached from horizons above.

Climax vegetation. The final stage of plant succession for a given natural environment; the stage at which the composition of the plant community remains unchanged and can reproduce itself as long as the environment remains unchanged.

Colluvium. Material that has been moved downhill by gravity, soil creep, frost action, or local erosion. It accumulates on lower slopes and at the foot of slopes.

Complex, soil. An intricate mixture of areas of different kinds of soil that are too small to be shown separately on a publishable soil map. The whole group of soils must be shown together as a mapping unit and described as a pattern of soils.

Consistence. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are as follows:

Loose. Noncoherent; will not hold together in a mass.

Friable. When moist, crushes easily under moderate pressure between thumb and forefinger, and can be pressed together into a lump.

Firm. When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic. When wet, readily deformed by moderate pressure, but can be pressed into a lump; will form a wire when rolled between thumb and forefinger.

Sticky. When wet, adheres to other material.

Hard. When dry, moderately resistant to pressure; can barely be broken between thumb and forefinger.

Cemented. Hard and brittle; little affected by moistening.

Contour farming. Conducting plowing, planting, cultivating, harvesting, and other field operations on the contour or at right angles to the natural direction of slope.

Cretaceous. A period of geologic time between 60 and 130 million years ago. Also, geologic materials deposited during the Cretaceous period.

Dendritic. Branching, like a shrub or tree; usually said of river systems, various plants, and of the veins of leaves of many higher plants.

Deflation. The formation of a depression through the removal of loose soil materials by high winds.

Dispersion, soil. The breaking down of soil aggregates, resulting in single-grain structure. Ease of dispersion is an important factor influencing the erodibility of soils. Generally speaking, the more easily dispersed the soil, the more erodible it is.

Dryland farming. Generally, producing crops that require some tillage in subhumid to semiarid areas without irrigation. The system usually involves periods of fallow between crops during which water from precipitation is absorbed and retained. The fallow period is usually 1 or 2 years for each year of cropping.

Eolian deposits. Wind-deposited materials moved fairly short distances and accumulated in dunes; generally, coarse textured.

Genesis, soil. The mode of origin of the soil. Soil genesis refers particularly to the processes causing the development of the solum, or true soil, from unconsolidated parent materials.

Great soil group. Any one of several broad groups of soils with fundamental characteristics in common.

Horizon, soil. A layer of soil, approximately parallel to the soil surface, with characteristics produced by soil-forming processes. The relative positions of the several soil horizons in the soil profile and their nomenclature are given below.

Horizon A. The master horizon consisting of (1) one or more mineral horizons of maximum organic accumulation; or (2) surface or subsurface horizons that are lighter in color than the underlying horizon and which have lost clay minerals, iron, and aluminum with resultant concentration of the more resistant minerals; or (3) horizons belonging to both of these categories.

Horizon B. The master horizon of altered material characterized by (1) an accumulation of clay, iron, or aluminum, with accessory organic material; or (2) blocky or prismatic structure together with other characteristics, such as stronger colors, unlike those of the A horizons or the underlying horizons of nearly unchanged material; or (3) characteristics of both these categories. Commonly, the lower limit of the B horizon corresponds to the lower limit of the solum.

Horizon C. A layer of unconsolidated material, relatively little affected by the influence of organisms and in chemical, physical, and mineralogical composition presumed to be similar to the material from which at least part of the overlying solum has developed.

Horizon D. Any stratum underlying the C, or the B if no C is present, which is unlike the C, or unlike the material from which the solum has been formed.

Humus. The well-decomposed, more or less stable part of the organic matter in mineral soils.

Intrazonal soils. Any one of the great groups of soils having more or less well-developed soil characteristics that reflect a dominating influence of some local factor of relief or parent material over the normal influences of climate and vegetation.

Listing. A type of tillage in which the plowshares throw the soil in opposite directions and leave the field with alternate ridges and furrows. This type of tillage is used on the High Plains to form a roughened surface for protection against erosion by wind.

Loess. Geological deposit of fairly uniform, fine material, mostly silt, presumably transported by the wind.

Miscellaneous land types. Rough, stony, and severely gullied land or fresh stream deposits of variable texture. They have little true soil and are not classified by soil types and series but are identified by descriptive names. An example is Rough broken land.

Ogallala formation. The water-bearing geologic formation that underlies the High Plains, extending to a depth of several hundred feet. It is comprised of alluvial outwash of the Pliocene epoch.

Parent material. The unconsolidated mass of rock material (or peat) from which the soil profile develops.

Ped. An individual natural soil aggregate, such as a crumb, prism, or block, in contrast to a clod, which is a mass of soil brought about by digging or other disturbance.

Permeability, soil. That quality of the soil that enables it to transmit air and water. *Moderately permeable* soils transmit air and water readily. Such conditions are favorable for root growth. *Slowly permeable* soils allow water and air to move so slowly that root growth may be restricted. *Rapidly permeable* soils transmit air and water rapidly, and root growth is good.

Permian. A period of geologic time that occurred between 185 and 210 million years ago; refers to geologic materials deposited during the Permian period.

Phase, soil. A subdivision of the soil type covering variations that are chiefly in such external characteristics as relief, stoniness, or accelerated erosion.

Playa. A flat-bottomed, undrained basin that contains shallow water for short periods following rains.

Pleistocene. A geologic epoch that occurred between 25 thousand and a million years ago; refers to geologic materials deposited during that time.

Pliocene. A geologic epoch that occurred between 1 million and 12 million years ago; refers to geologic materials deposited during that time.

Poorly graded soil. Coarse-grained soil with soil particles of fairly uniform size.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material. (See Horizon, soil).

Range site. Kinds of rangeland that differ from each other in their ability to produce a significantly different kind or amount of climax or original vegetation. A significant difference means one large enough to require different grazing use or management to maintain or improve the resource.

Reaction. The degree of acidity or alkalinity of a soil mass. Expressed in this report by the following: *Noncalcareous; slightly calcareous; weakly calcareous; strongly calcareous:* and *very strongly calcareous.*

Recent. The later of the two geologic epochs in the Quaternary period, in the classification generally used. Also the deposits formed during that epoch. The Recent comprises all geologic time and deposits from the close of the Pleistocene, or Glacial, epoch until and including the present.

Red beds. Materials deposited in Triassic or Permian formations, or both, which are characteristically reddish in color.

Readily available moisture. The amount of moisture in the soil that plants can obtain from the soil while maintaining rapid growth.

Relief. Elevations or inequalities of the land surface, considered collectively.

Runoff. Water that flows away over the surface of the soil without sinking in.

Sand. Individual rock or mineral fragments in soils having diameters ranging from 0.05 millimeter (0.002 inch) to 2.0 millimeters (0.079 inch). Usually sand grains consist chiefly of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more of sand and not more than 10 percent of clay.

Series, soil. A group of soils having genetic horizons that, except for the texture of the surface soil, are similar as to differentiating characteristics and arrangement in the soil profile, and developed from a particular type of parent material. A series may include two or more soil types that differ from one another in the texture of the surface soil.

Shrink-swell potential. An estimate of how much a soil shrinks and swells under extremes of dryness and wetness. A knowledge of this potential is important in planning the use of a soil for building roads and other engineering structures.

Silt. Individual mineral particles of soil that range in diameter from the upper size of clay, 0.002 millimeter, to the lower size of very fine sand, 0.05 millimeter. Soil of the textural class called silt contains 80 percent or more of silt and less than 12 percent of clay.

Soil. The natural medium for the growth of land plants.

Solum. The part of the soil profile, above the unweathered parent material, in which the processes of soil formation are active. In mature soils the solum consists of the A and B horizons.

Structure. The arrangement of individual soil particles into aggregates with definite shape or pattern. Structure is described in terms of *class, grade,* and *type.*

Class. Refers to the size of the soil aggregates.

Grade. Distinctness and durability of the aggregates. Grade is expressed as *weak, moderate,* or *strong.* Soil that has no visible structure is termed massive if coherent, or single grain if noncoherent.

Type. Shape and arrangement of the aggregates. *Granular, blocky,* and *prismatic* types of structure predominate in soils of Carson County.

Stubble-mulch tillage. A type of tillage used in areas subject to wind erosion; subtillage sweeps loosen the subsoil and eradicate weeds but leave the crop stubble more or less undisturbed.

Subsurface tillage. Tillage with a sweeplike plow or blade that does not turn over the surface cover or incorporate it into the lower part of the surface soil.

Terrace (for control of runoff or soil erosion or both). An embankment or ridge constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surplus runoff to retard it for infiltration into the soil so that any excess may flow slowly to a prepared outlet without harm.

Texture, soil. The relative proportions of sand, silt, and clay particles in the soil (See Sand; Clay; Silt).

Coarse-textured soil. Contains a large proportion of sand, is loose and noncoherent when dry, and is generally relatively low in fertility and moisture-holding capacity; highly erodible.

Moderately coarse textured soil. High sand content but has enough silt and clay to form fragile clods; individual sand grains easily seen, and soil mass feels gritty; highly erodible.

Medium-textured soil. About equal proportions of sand, silt, and clay; generally friable but forms stable clods.

Moderately fine textured soil. Contains large amount of clay; generally absorbs water slowly and is more difficult to cultivate than coarse-textured soil.

Fine-textured soil. Contains large proportion of clay; normally hard when dry and plastic when wet.

Tillage pan. A dense, highly compact zone occurring in the soil just below normal tillage depth; caused by tilling when the soil is moist and compact.

Tilth, soil. The condition of the soil in its relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topography. The elevations or inequalities of the land surface. In soil descriptions the more specific terms—relief, physiography, landform, or slope—should be used.

Toposequence. A group or sequence of geographically associated soils, developed from essentially similar parent materials, in which the soil characteristics differ primarily because of the influence of variations in topography and drainage.

Type, soil. A subdivision of the soil series based on the texture of the surface soil.

Undifferentiated mapping unit. Two or more soils that do not occur in regular geographic association that are mapped as an undifferentiated group.

Well-graded soils. Coarse-grained soils that vary widely in size of particles.

Zonal soils. Soils having well-developed characteristics that reflect the influence of the active factors of soil formation. The active factors are climate and living organisms, chiefly vegetation.

GUIDE TO MAPPING UNITS, CAPABILITY UNITS, AND RANGE SITES

[See table 1, p. 5, for approximate acreage and proportionate extent of the soils, and table 3, p. 30, for estimated average yields for cultivated soils under two levels of management]

Map symbol	Mapping unit	Page	Capability unit Dryland	Page	Capability unit Irrigated	Page	Range site
Au	Alluvial land	6	Vw-1	25	--------		Bottom Land.
BeC	Berthoud fine sandy loam, 3 to 5 percent slopes.	6	IVe-2	24	IVe-2	24	Mixed Land Slopes.
BfD	Berthoud and Mansker fine sandy loams, 3 to 8 percent slopes.	6	VIe-2	25	--------		Mixed Land Slopes.
BmD	Berthoud and Mansker loams, 3 to 8 percent slopes.	7	VIe-1	25	--------		Hardland Slopes.
BrB	Bippus clay loam, 1 to 3 percent slopes	7	IIIe-2	23	IIIe-2	23	Hardland.
DaB	Dalhart fine sandy loam, 1 to 3 percent slopes.	8	IIIe-3	24	IIIe-3	24	Mixed Land.
DaC	Dalhart fine sandy loam, 3 to 5 percent slopes.	8	IVe-2	24	IVe-2	24	Mixed Land.
DmC	Dalhart-Mansker loams, 3 to 5 percent slopes.	8	VIe-1	25	--------		Hardland Slopes.
Gr	Gravelly rough land	9	VIIs-1	25	--------		Rough Breaks.
Lk	Likes loamy fine sand, hummocky	9	VIIe-1	25	--------		Sandy Land.
Lo	Lofton silty clay loam	10	IIIce-1	22	IIs-1	22	Hardland.
Ls	Lofton and Church soils	10	IIIce-1	22	IIs-1	22	Hardland.
MkB	Mansker loam, 1 to 3 percent slopes	11	IVe-2	24	IVe-2	24	Hardland.
MkC	Mansker loam, 3 to 5 percent slopes	11	VIe-1	25	--------		Hardland Slopes.
MkC2	Mansker loam, 3 to 5 percent slopes, eroded	11	VIe-1	25	--------		Hardland Slopes.
Mx	Mansker-Potter-Berthoud sandy loams	12	VIe-2	25	--------		Mixed Land Slopes.
OcB	Olton clay loam, 1 to 3 percent slopes	12	IIIe-1	23	IIIe-1	23	Hardland.
OcC	Olton clay loam, 3 to 5 percent slopes	13	IVe-1	24	--------		Hardland.
Ps	Potter soils	13	VIIs-2	26	--------		Shallow Land.
PuA	Pullman silty clay loam, 0 to 1 percent slopes	14	IIIce-1	22	IIs-1	22	Hardland.
PuB	Pullman silty clay loam, 1 to 3 percent slopes.	14	IIIe-1	23	IIIe-1	23	Hardland.
PuB2	Pullman silty clay loam, 1 to 3 percent slopes, eroded.	15	IVe-1	24	--------		Hardland.
Ra	Randall clay	15	VIw-1	25	--------		Hardland.
RcB	Richfield clay loam, 1 to 3 percent slopes	16	IIIe-1	23	IIIe-1	23	Hardland.
Ro	Rough broken land	16	VIIs-1	25	--------		Rough Breaks.
Rs	Rough stony land	16	VIIs-1	25	--------		Rough Breaks.
Rw	Riverwash	16	--------		--------		
Sc	Spur clay loam	17	IIIce-2	21	IIe-1	21	Hardland.
Sp	Spur fine sandy loam	17	IIIe-3	24	IIe-2	22	Mixed Land Slopes.
Tv	Tivoli fine sand	17	VIIe-1	25	--------		Sandy Land.
UcA	Ulysses clay loam, 0 to 1 percent slopes	18	IIIce-2	21	IIe-1	21	Hardland.
UcB	Ulysses clay loam, 1 to 3 percent slopes	18	IIIe-2	23	IIIe-2	23	Hardland.
UcB2	Ulysses clay loam, 1 to 3 percent slopes, eroded.	19	IVe-1	24	--------		Hardland.
VoB	Vona fine sandy loam, 1 to 3 percent slopes	19	IIIe-3	24	IIIe-3	24	Mixed Land.
ZcA	Zita clay loam, 0 to 1 percent slopes	20	IIIce-2	21	IIe-1	21	Hardland.
ZcB	Zita clay loam, 1 to 3 percent slopes	20	IIIe-2	23	IIIe-2	23	Hardland.

UNITED STATES DEPARTMENT OF AGRICULTURE

1862 1962

Growth Through Agricultural Progress

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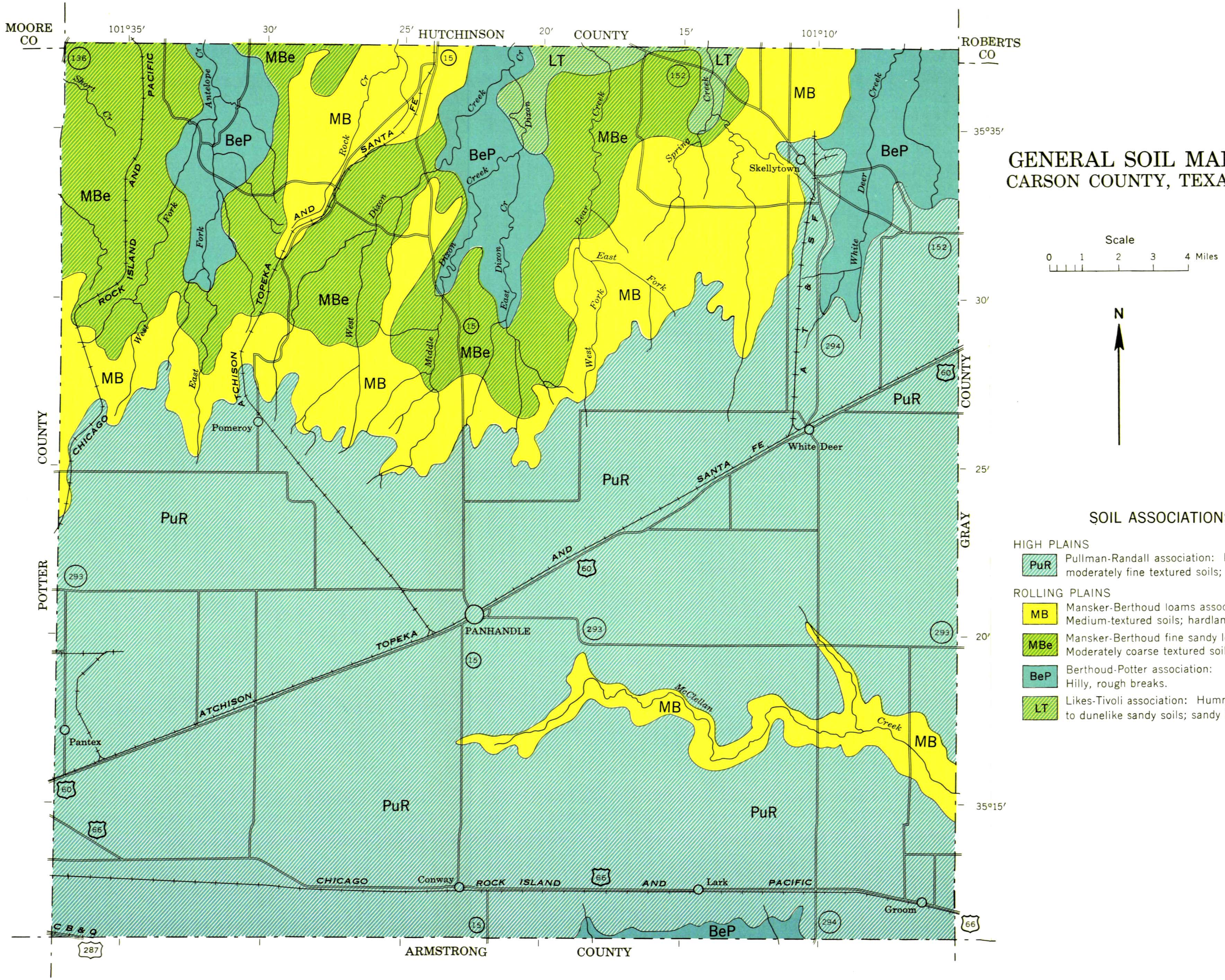


GENERAL SOIL MAP
CARSON COUNTY, TEXAS

SOIL ASSOCIATIONS

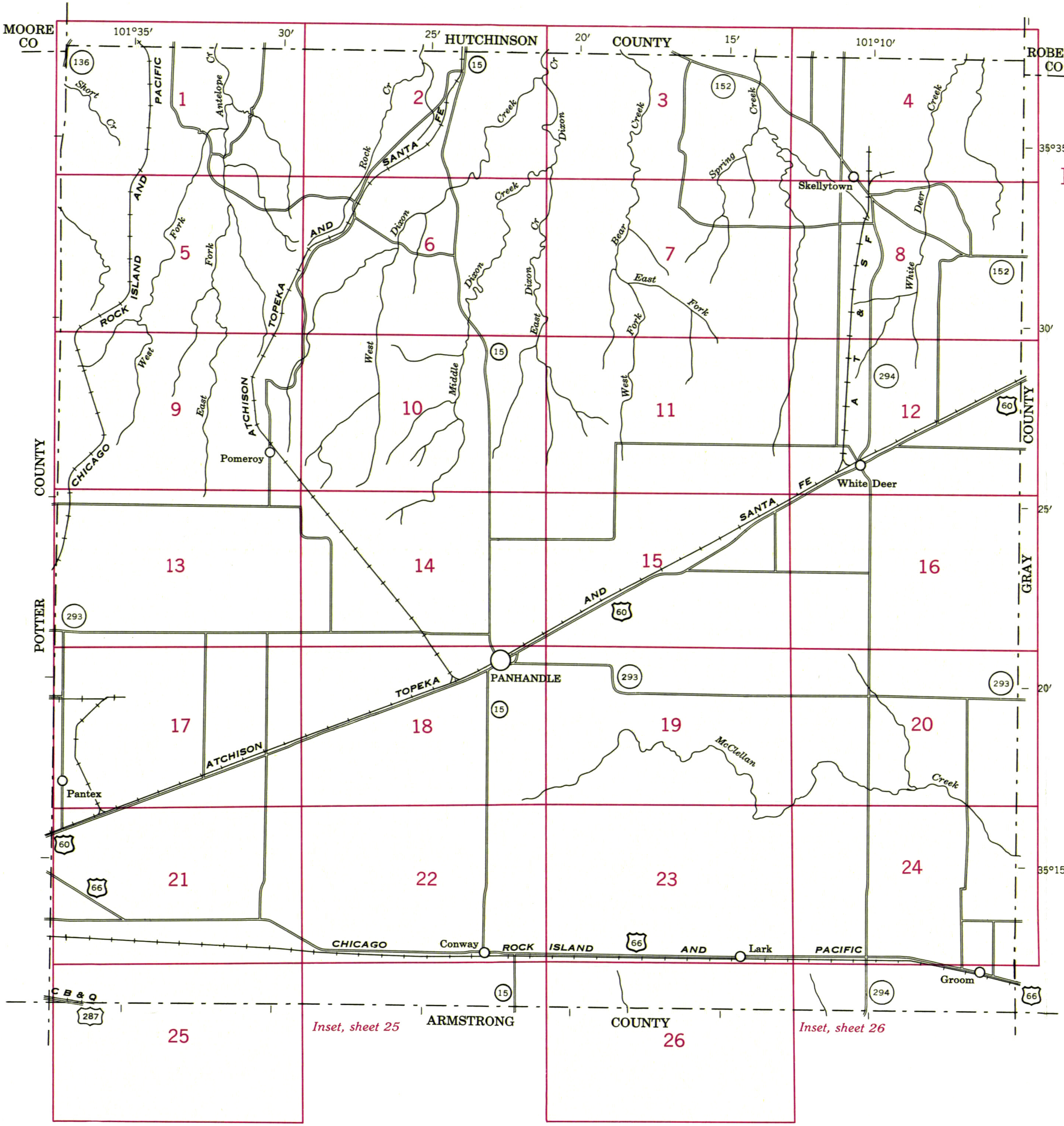
HIGH PLAINS

- **PuR** Pullman-Randall association: Fine or moderately fine textured soils; hardlands.

ROLLING PLAINS

- **MB** Mansker-Berthoud loams association: Medium-textured soils; hardlands.
- **MBe** Mansker-Berthoud fine sandy loams association: Moderately coarse textured soils; mixed lands.
- **BeP** Berthoud-Potter association: Hilly, rough breaks.
- **LT** Likes-Tivoli association: Hummocky to dunelike sandy soils; sandy lands.

INDEX TO MAP SHEETS
CARSON COUNTY, TEXAS



U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

CARSON COUNTY, TEXAS

TEXAS AGRICULTURAL EXPERIMENT STAT

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads
- Dual
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail, foot
- Railroad
- Ferries
- Ford
- Grade
- R. R. over
- R. R. under

Tunnel

Buildings
- School
- Church
- Station

Mines and Quarries

Mine dump

Pits, gravel or other

Power lines

Pipe lines

Cemeteries

Dams

Levees

Tanks

Oil wells

Windmills

BOUNDARIES

- National or state
- County
- Township, U. S.
- Land division corner
- Reservation
- Land grant

DRAINAGE

Streams
- Perennial
- Intermittent, unclass.

Canals and ditches — CANAL / DITCH

Lakes and ponds
- Perennial
- Intermittent

Wells irrigation — I W

Springs

Marsh

Wet spot

RELIEF

Escarpments
- Bedrock
- Other

Prominent peaks

Depressions (Large / Small)
- Crossable with tillage implements
- Not crossable with tillage implements
- Contains water most of the time

SOIL SURVEY DATA

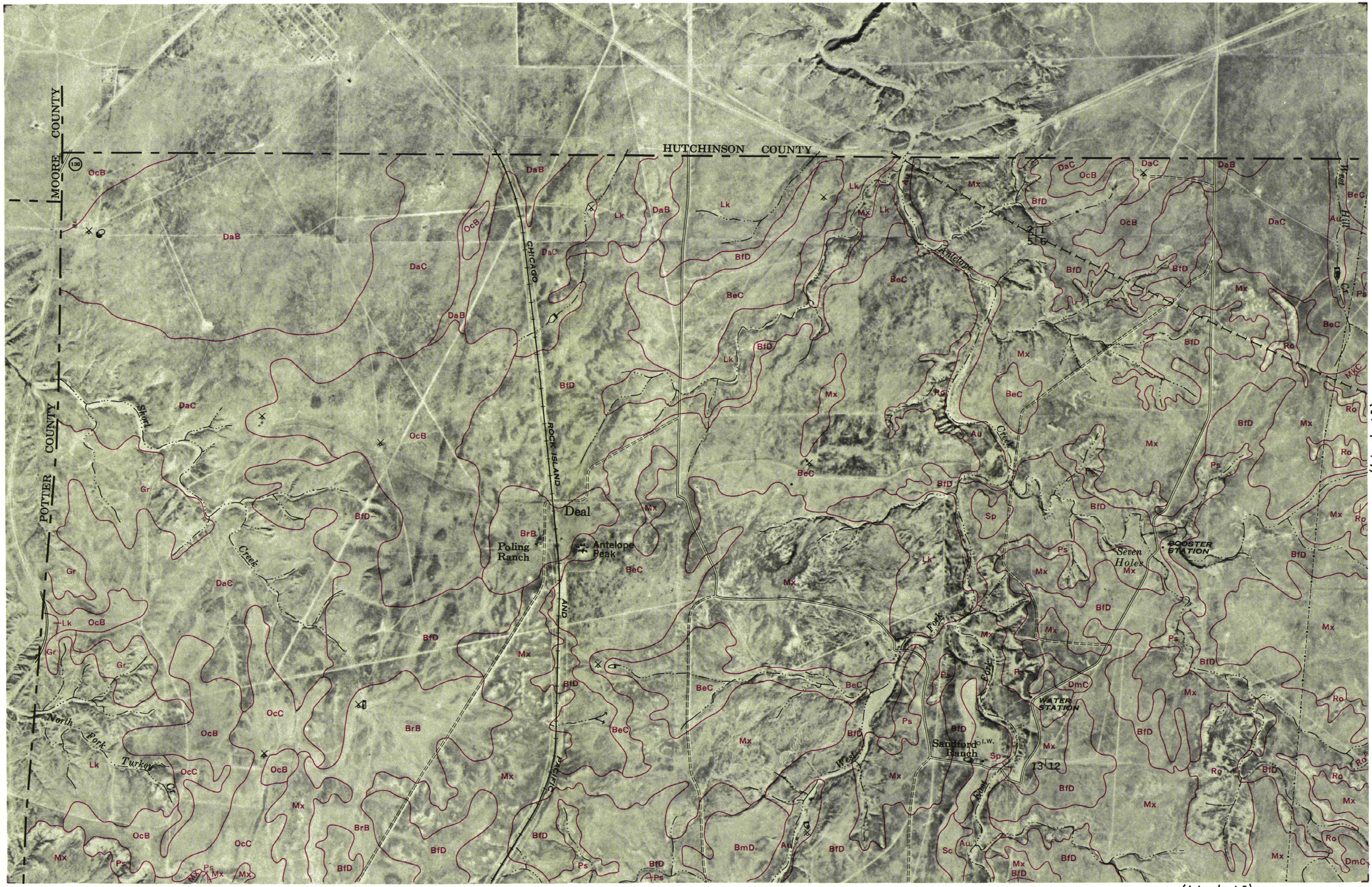
- Soil boundary and symbol — Dx
- Gravel
- Stones
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gullies

SOIL LEGEND

The first capital letter is the initial one of the soil name. A second capital letter, A, B, C, or D, shows the slope. Symbols without a slope letter are those of nearly level soils, such as Spur clay loam, or of soils that have a considerable range of slope, such as Potter soils. A final number, 2, shows that the soil is eroded.

SYMBOL	NAME
Au	Alluvial land
BeC	Berthoud fine sandy loam, 3 to 5 percent slopes
BfD	Berthoud and Mansker fine sandy loams, 3 to 8 percent slopes
BmD	Berthoud and Mansker loams, 3 to 8 percent slopes
BrB	Bippus clay loam, 1 to 3 percent slopes
DaB	Dalhart fine sandy loam, 1 to 3 percent slopes
DaC	Dalhart fine sandy loam, 3 to 5 percent slopes
DmC	Dalhart-Mansker loams, 3 to 5 percent slopes
Gr	Gravelly rough land
Lk	Likes loamy fine sand, hummocky
Lo	Lofton silty clay loam
Ls	Lofton and Church soils
MkB	Mansker loam, 1 to 3 percent slopes
MkC	Mansker loam, 3 to 5 percent slopes
MkC2	Mansker loam, 3 to 5 percent slopes, eroded
Mx	Mansker-Potter-Berthoud sandy loams
OcB	Olton clay loam, 1 to 3 percent slopes
OcC	Olton clay loam, 3 to 5 percent slopes
Ps	Potter soils
PuA	Pullman silty clay loam, 0 to 1 percent slopes
PuB	Pullman silty clay loam, 1 to 3 percent slopes
PuB2	Pullman silty clay loam, 1 to 3 percent slopes, eroded
Ra	Randall clay
RcB	Richfield clay loam, 1 to 3 percent slopes
Ro	Rough broken land
Rs	Rough stony land
Rw	Riverwash
Sc	Spur clay loam
Sp	Spur fine sandy loam
Tv	Tivoli fine sand
UcA	Ulysses clay loam, 0 to 1 percent slopes
UcB	Ulysses clay loam, 1 to 3 percent slopes
UcB2	Ulysses clay loam, 1 to 3 percent slopes, eroded
VoB	Vona fine sandy loam, 1 to 3 percent slopes
ZcA	Zita clay loam, 0 to 1 percent slopes
ZcB	Zita clay loam, 1 to 3 percent slopes

Soil map constructed 1961 by Cartographic Division, Soil Conservation Service, USDA, from 1953 aerial photographs. Controlled mosaic based on Texas plane coordinate system, north zone, Lambert conformal conic projection, 1927 North American datum.



(Joins sheet 5)

0 1/2 1 Mile Scale 1:31680 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Land division corners and numbers shown on this map are indefinite

CARSON COUNTY, TEXAS - SHEET NUMBER 2

N

(Joins sheet 1)

(Joins sheet 3)

(Joins sheet 6)

0 1/2 1 Mile Scale 1:31680 0 5000 Feet

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Land division corners and numbers shown on this map are indefinite

(Joins sheet 2)

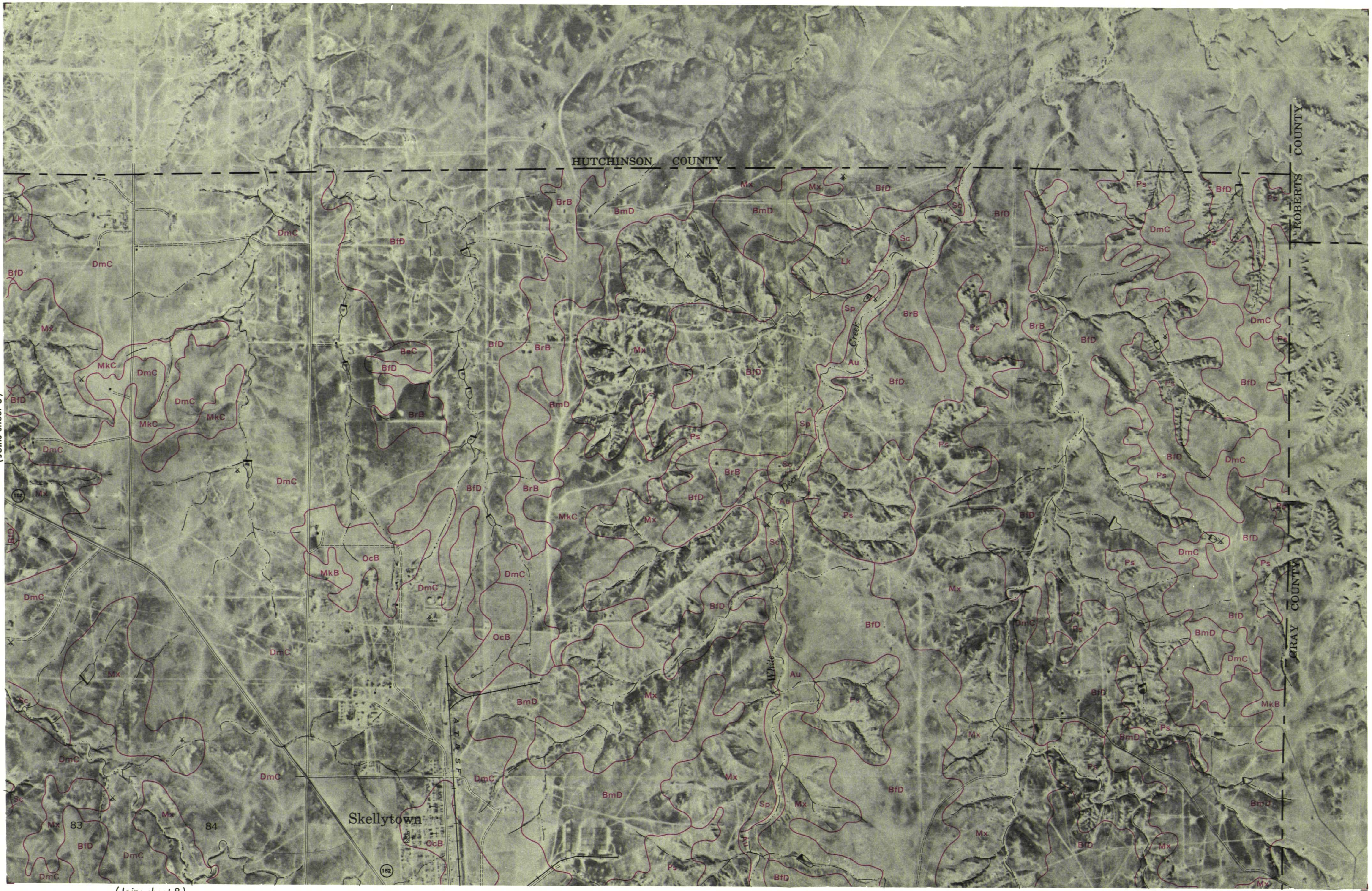
(Joins sheet 4)

(Joins sheet 7)

0 1/2 1 Mile Scale 1:31680 0 5000 Feet

4

N

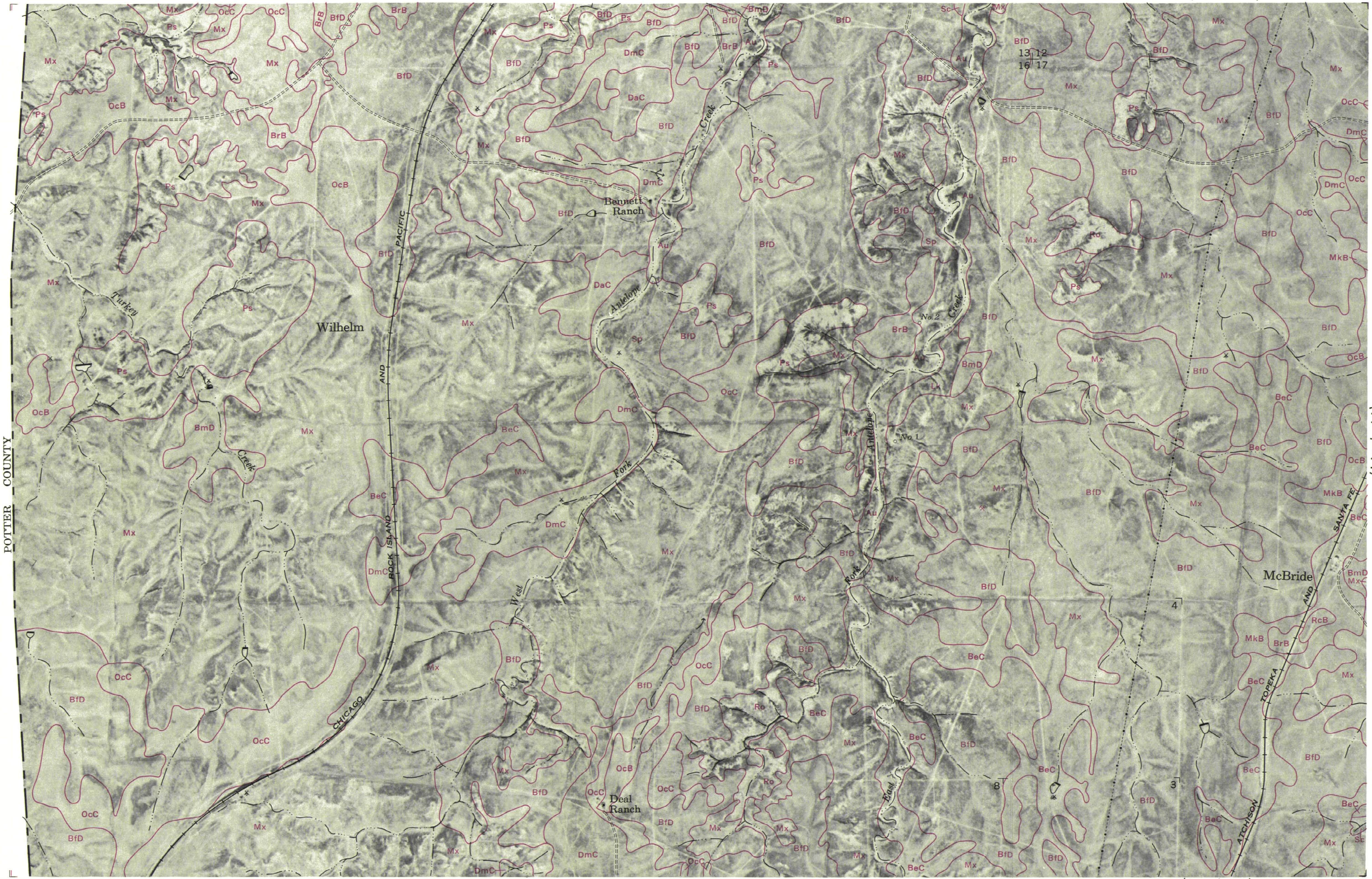


(Joins sheet 3)

(Joins sheet 8)

0 1/2 1 Mile Scale 1:31680 0 5000 Feet

(Joins sheet 1)



(Joins sheet 6)

(Joins sheet 9)

0 ½ 1 Mile Scale 1:31680 0 5000 Feet

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Land division corners and numbers shown on this map are indefinite

CARSON COUNTY, TEXAS - SHEET NUMBER 6

(Joins sheet 2)

N

(Joins sheet 5)

(Joins sheet 7)

(Joins sheet 10)

0 1/2 1 Mile Scale 1:31680 0 5000 Feet

(Joins sheet 3)

(Joins sheet 6)

(Joins sheet 8)

N

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Land division corners and numbers shown on this map are indefinite

(Joins sheet 11)

0 ½ 1 Mile Scale 1:31680 0 5000 Feet

CARSON COUNTY, TEXAS - SHEET NUMBER 8

(Joins sheet 4)

N

(Joins sheet 7)

(Joins sheet 12)

0 ½ 1 Mile Scale 1:31680 0 5000 Feet

9

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Land division corners and numbers shown on this map are indefinite

(Joins sheet 5)

(Joins sheet 13)

0 ½ 1 Mile

Scale 1:31680

0 5000 Feet

10

CARSON COUNTY, TEXAS - SHEET NUMBER 10

CARSON COUNTY, TEXAS - SHEET NUMBER 11

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Land division corners and numbers shown on this map are indefinite

CARSON COUNTY, TEXAS - SHEET NUMBER 12

(Joins sheet 8)

(Joins sheet 11)

(Joins sheet 16)

0 ½ 1 Mile Scale 1:31680 0 5000 Feet

CARSON COUNTY, TEXAS - SHEET NUMBER 13

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

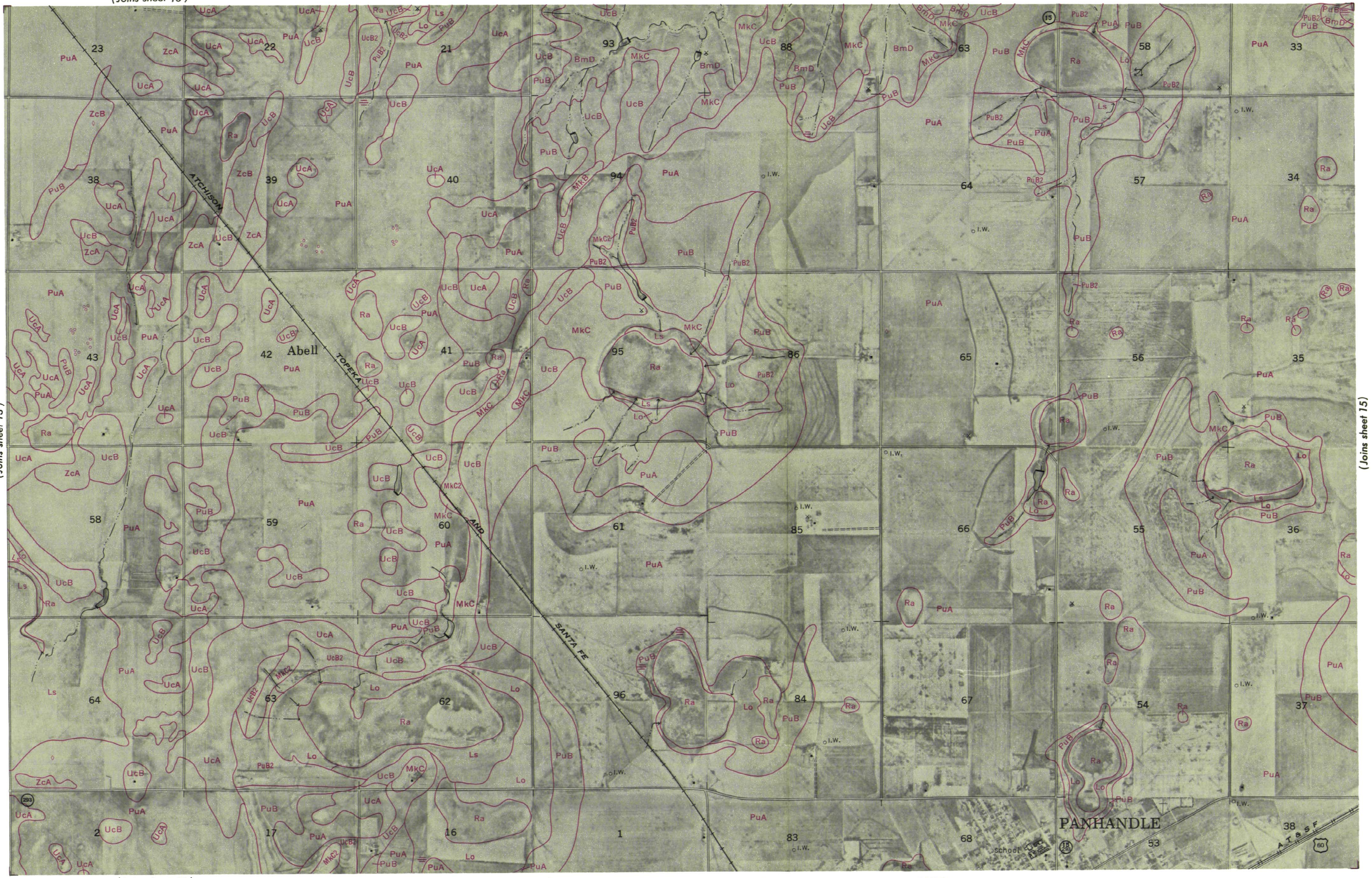
Land division corners and numbers shown on this map are indefinite

CARSON COUNTY, TEXAS - SHEET NUMBER 14

(14)

(Joins sheet 10)

(Joins sheet 13)



(Joins sheet 15)

(Joins sheet 18)

0 1/2 1 Mile Scale 1:31680 0 5000 Feet

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Land division corners and numbers shown on this map are indefinite

Scale 1:31680

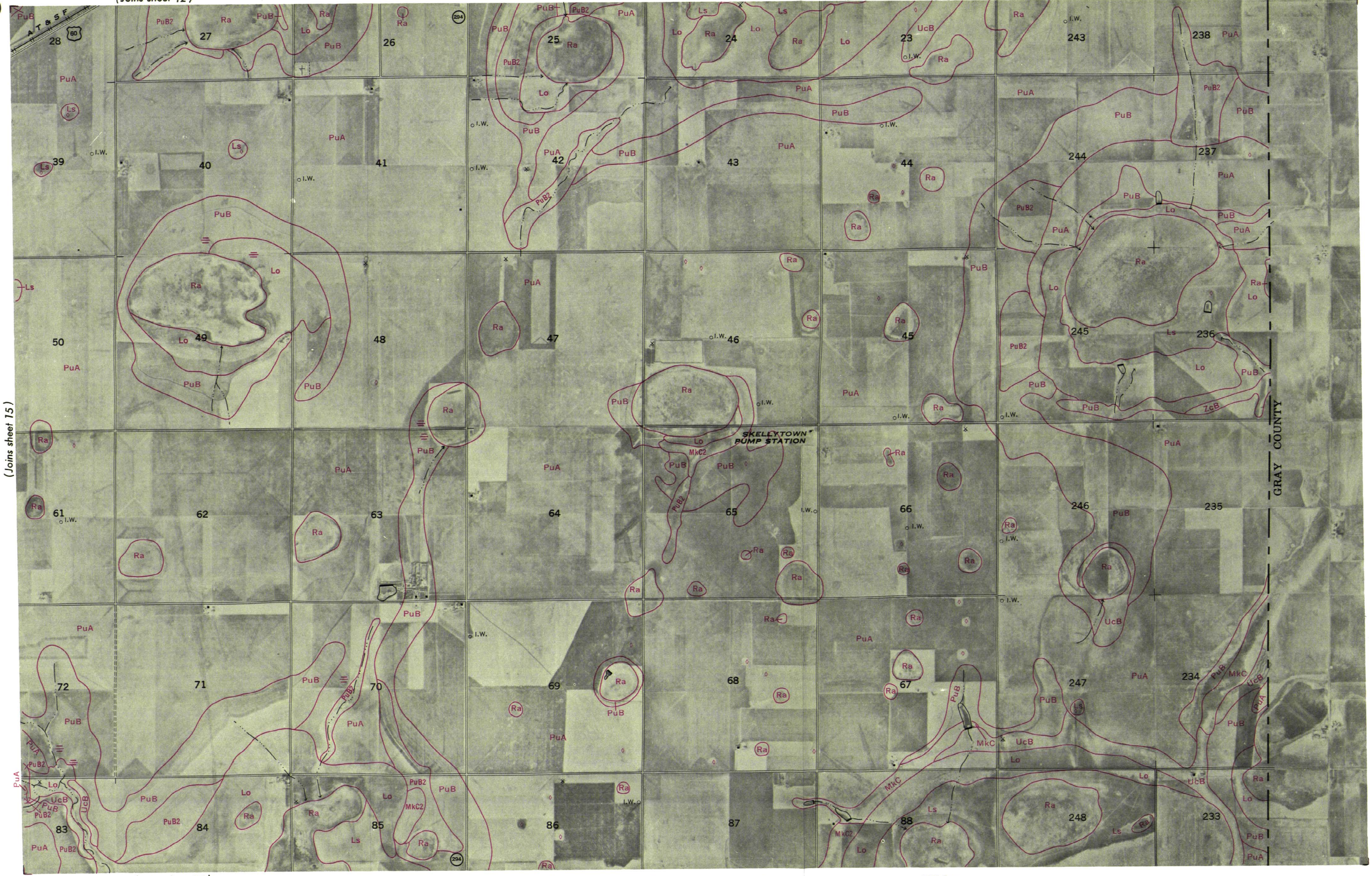
0 ½ 1 Mile

0 5000 Feet

CARSON COUNTY, TEXAS - SHEET NUMBER 16

(Joins sheet 12)

(Joins sheet 15)



(Joins sheet 20)

0 1/2 1 Mile

Scale 1:31680

0 5000 Feet

CARSON COUNTY, TEXAS - SHEET NUMBER 17

(Joins sheet 13)

17

N

(Joins sheet 18)

(Joins sheet 21)

0 1/2 1 Mile Scale 1:31680 0 5000 Feet

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Land division corners and numbers shown on this map are indefinite

CARSON COUNTY, TEXAS - SHEET NUMBER 18

18

(Joins sheet 14)

(Joins sheet 22)

0 1/2 1 Mile Scale 1:31680 0 5000 Feet

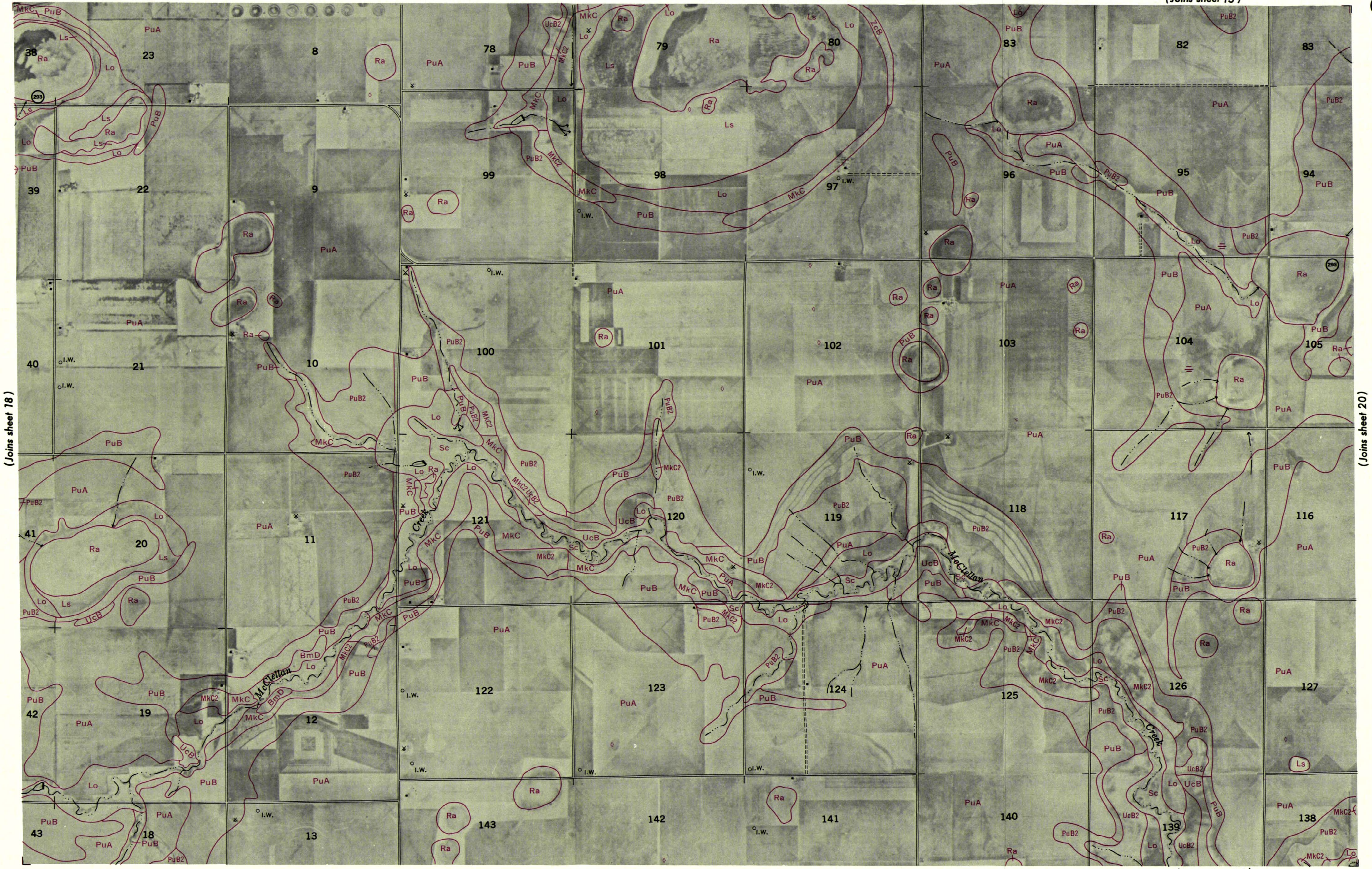
CARSON COUNTY, TEXAS - SHEET NUMBER 19

19

N

(Joins sheet 15)

(Joins sheet 18)



(Joins sheet 20)

(Joins sheet 23)

0 1/2 1 Mile Scale 1:31680 0 5000 Feet

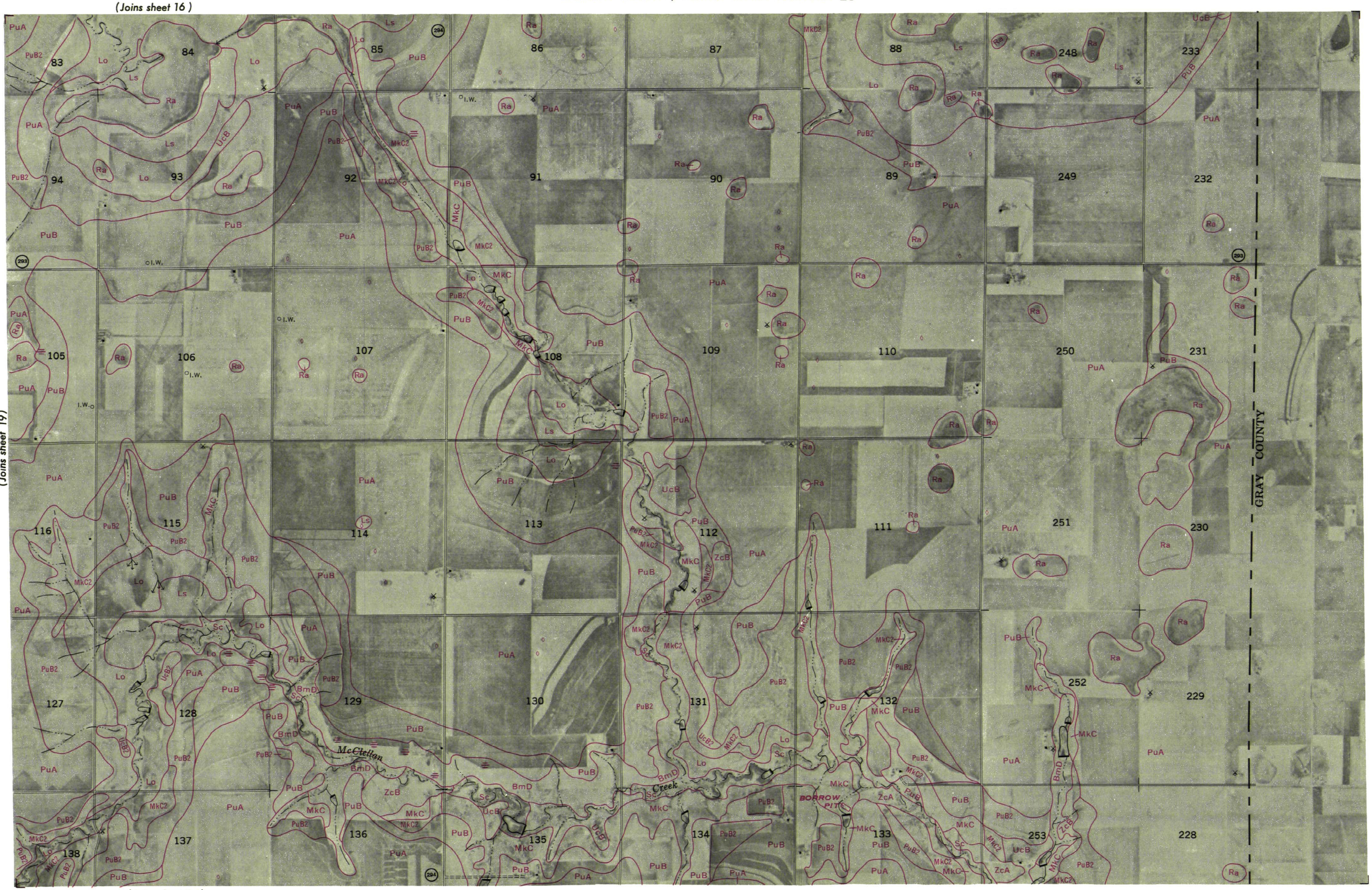
This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Land division corners and numbers shown on this map are indefinite

CARSON COUNTY, TEXAS - SHEET NUMBER 20

(20)

(Joins sheet 16)



(Joins sheet 24)

0 ½ 1 Mile Scale 1:31680 0 5000 Feet

CARSON COUNTY, TEXAS - SHEET NUMBER 21

(21)

(Joins sheet 17)

(Joins sheet 22)

(Joins sheet 25)

0 1/2 1 Mile Scale 1:31680 0 5000 Feet

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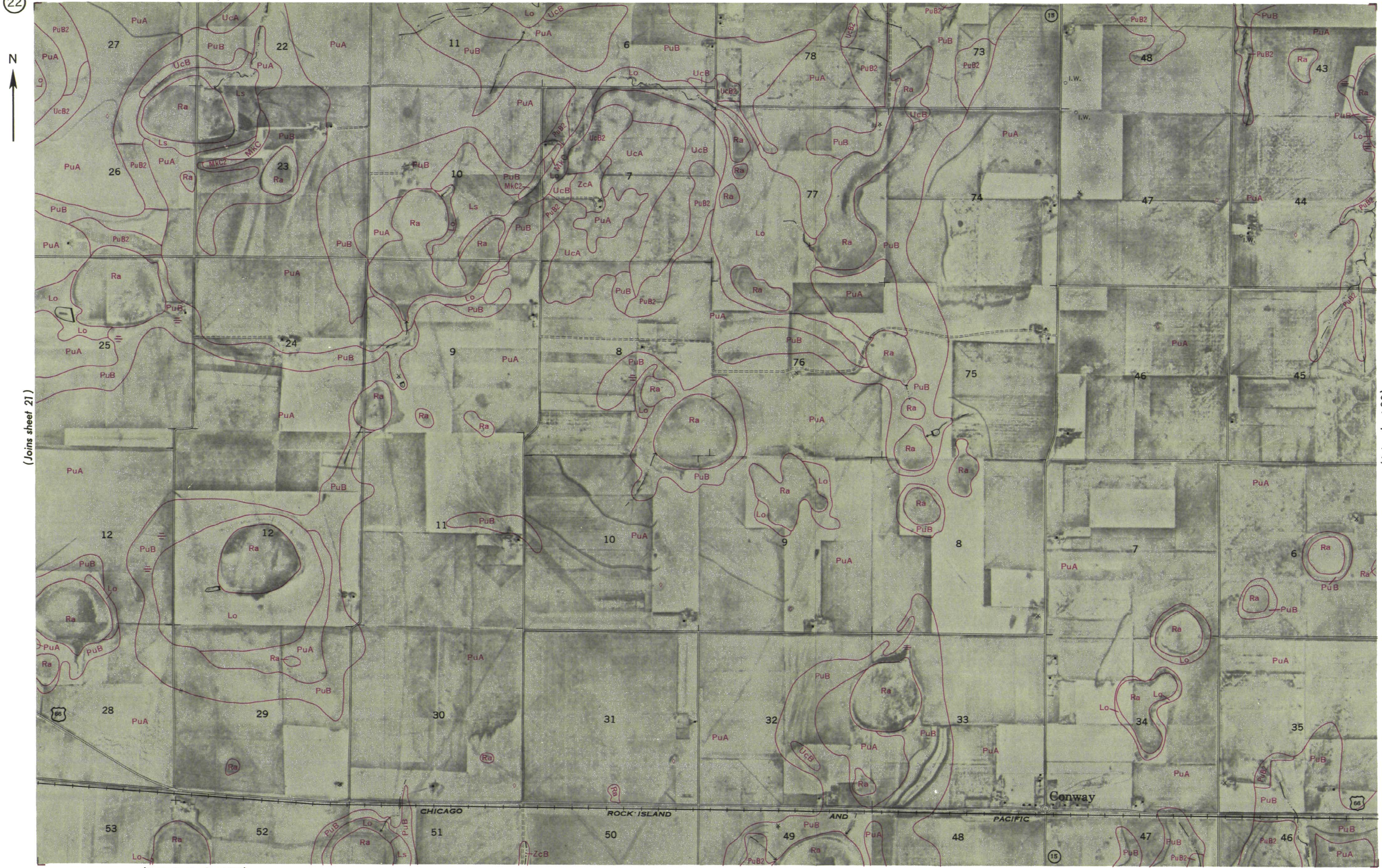
Land division corners and numbers shown on this map are indefinite

22

CARSON COUNTY, TEXAS - SHEET NUMBER 22

(Joins sheet 18)

(Joins sheet 21)



(Joins sheet 23)

(Joins inset, sheet 25)

0 1/2 1 Mile Scale 1:31680 0 5000 Feet

CARSON COUNTY, TEXAS - SHEET NUMBER 23

(23)

(Joins sheet 19)

(Joins sheet 22)

(Joins sheet 24)

(Joins sheet 26)

0 1/2 1 Mile Scale 1:31680 0 5000 Feet

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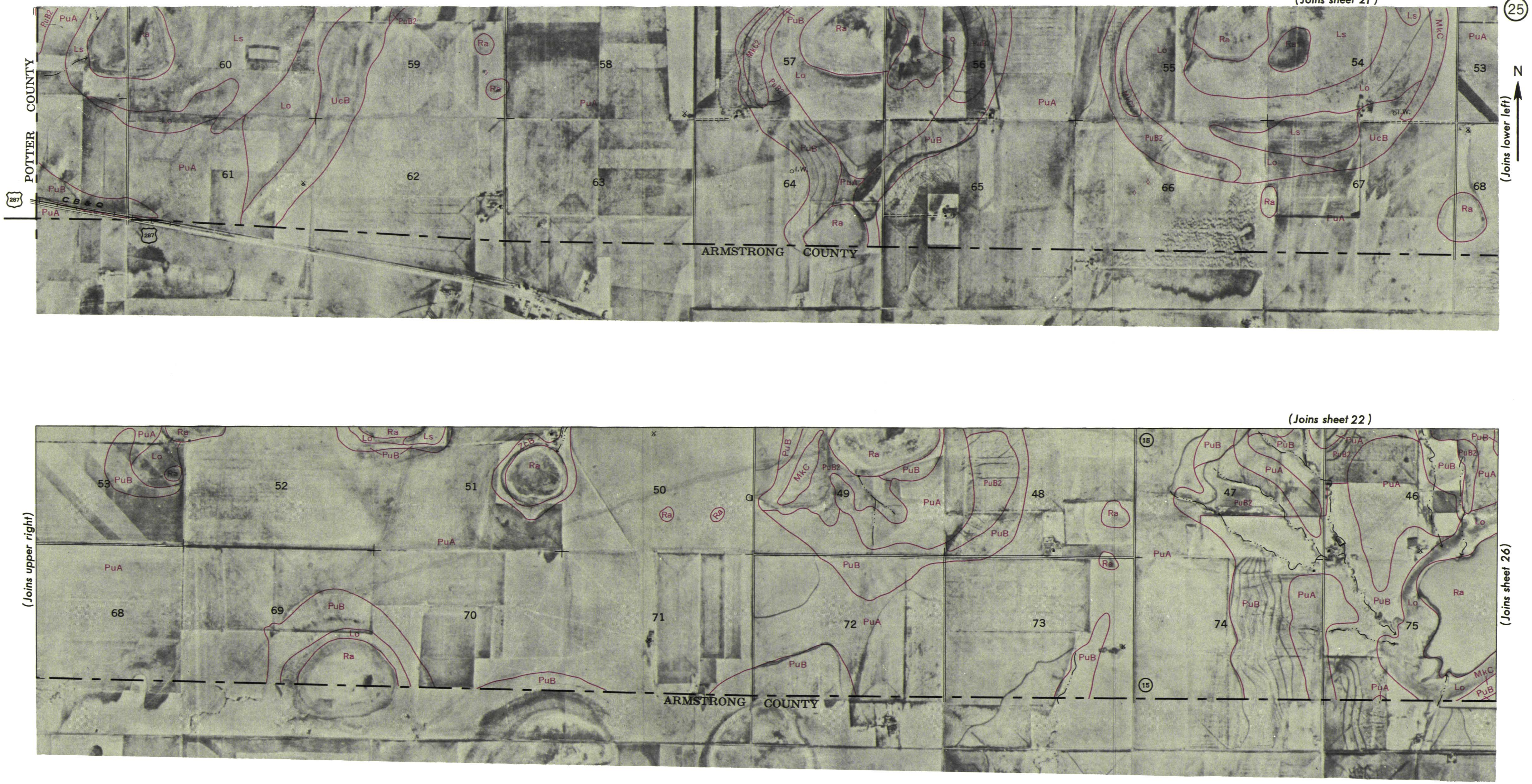
Land division corners and numbers shown on this map are indefinite

CARSON COUNTY, TEXAS - SHEET NUMBER 24

CARSON COUNTY, TEXAS - SHEET NUMBER 25



0 ½ 1 Mile Scale 1:31680 0 5000 Feet

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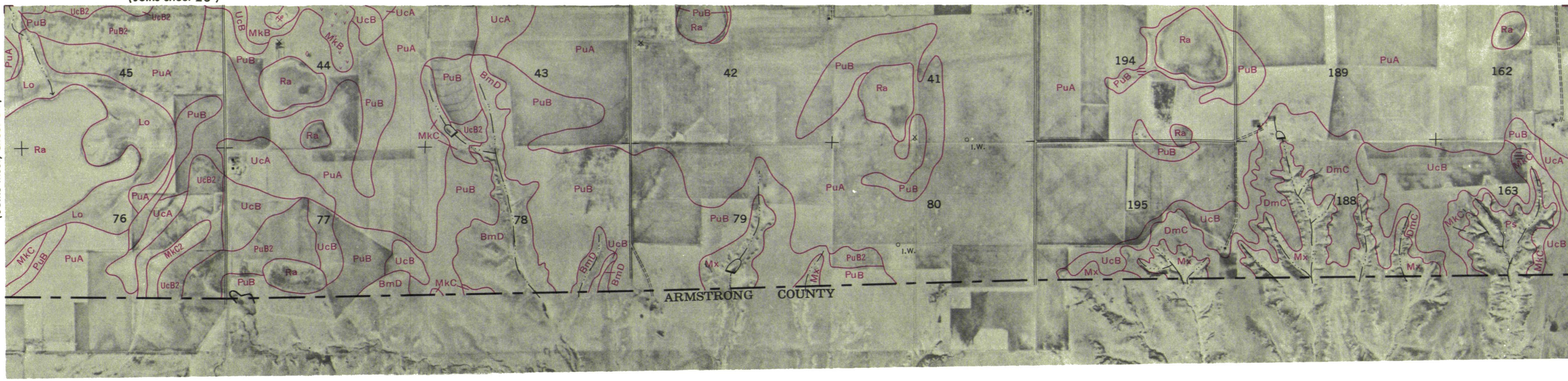
Land division corners and numbers shown on this map are indefinite

CARSON COUNTY, TEXAS - SHEET NUMBER 26

(Joins sheet 23)

N

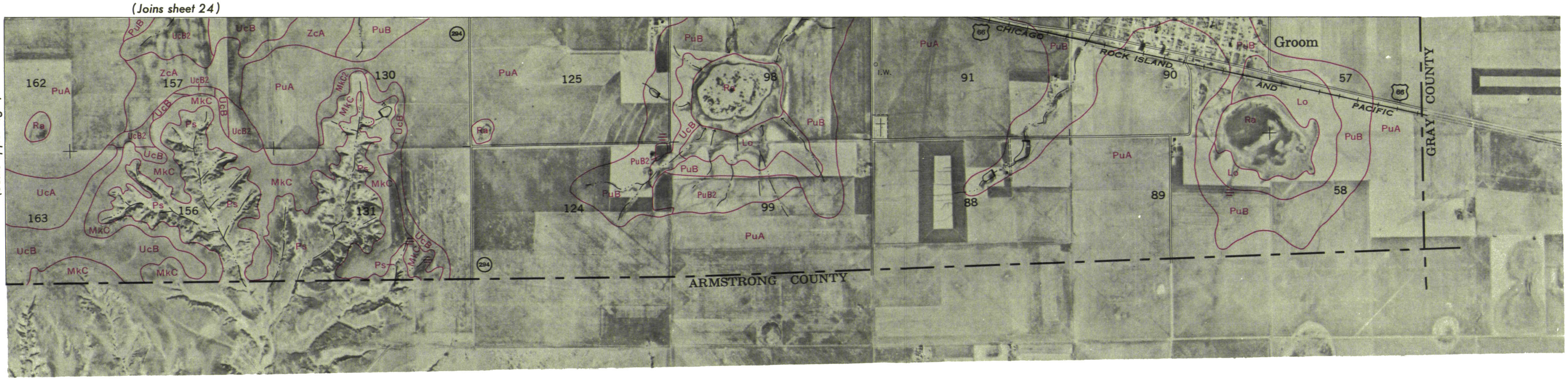
(Joins inset, sheet 25)



(Joins lower left)

(Joins sheet 24)

(Joins upper right)



0 ½ 1 Mile Scale 1:31680 0 5000 Feet